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ADVANCED COMPOSITE ELEVATOR FOR BOEING 727 AIRCRAFT

22 AUGUST 1977

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FIRST QUARTERLY TECHNICAL PROGRESS REPORT
24 MAY 1977 THROUGH 22 AUGUST 1977

PREPARED FOR:

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IN RESPONSE TO:

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BOEING COMMERCIAL AIRPLANE COMPANY
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Boeing Commercial
Airplane Company
Contract NAS1-14952

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With DRL Line Item Number 018

FIRST QUARTERLY TECHNICAL PROGRESS REPORT
24 May 1977 through 22 August 1977

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Contract NAS1-14952

FOREWARD

This report was prepared by the Boeing Commercial Aircraft Company, Renton, Washington, under Contract NAS1-14952. It is the first quarterly technical progress report covering preliminary precontract activities and work performed between program initiation on 24 May 1977 and 22 August 1977. The program is sponsored by the National Aeronautics and Space Administration, Langley Research Center (NASA-LRC). Dr. H. A. Leybold is the Project Manager for NASA-LRC.

The following Boeing personnel are principal contributors to the program during the reporting period: C. R. Zhender, Design; R. D. Wilson, Structural Analysis; M. Garvey, Manufacturing Specialists; D. Grant, Production Manager; L. D. Pritchett, Technical Operations Coordinator; D. V. Chovil, Business Support Manager; and C. F. Watson, Deputy Program Manager.

Boeing Commercial
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Contract NAS1-14952

SUMMARY

Program development efforts and preliminary design activities were devoted to developing an optimum elevator design and preparing an overall technical plan for development of an advanced composite elevator for the Boeing 727 commercial transport.

A strong desire by Boeing to obtain early production experience in advance composite structure, combined with delays in contract award, caused preliminary design and development activities to be well ahead of schedule. The results of this Boeing funded precontract preliminary design and development effort is included in the report, although not separately identified.

Preliminary design activities, which are essentially completed, consisted of conceiving, developing, and analyzing alternate design concepts, and finally selection of the optimum elevator design. This included trade studies in which durability, inspectability, producibility, repairability, and customer acceptability were evaluated. Preliminary development efforts consisted of evaluating and selecting material, identifying ancillary structural development test requirements, and defining full-scale ground and flight test requirements necessary to obtain Federal Aviation Administration (FAA) certification.

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INTRODUCTION

The escalation of jet-fuel prices is causing a reassessment of technology concepts and trades used in designing and building commercial airplanes. The task is to incorporate fuel-saving concepts into commercial aircraft design.

The potential weight savings and fuel reduction resulting from the use of advanced composites in aircraft structure are significant. However, the lack of technical confidence and cost data has delayed their use in commercial aircraft.

Hardware programs conducted in a production environment are required to establish and demonstrate the safety, operating-life characteristics, and manufacturing cost of advanced composite structures.

Boeing's approach to the problem is to obtain reliable production, technical, and cost data bases by the integration of advance composite technology development under NASA contracts, combined with the technology derived from an extension and acceleration of the company-sponsored development plan. This approach addresses these data bases, and develops realistic production costs in a commercial transport manufacturing environment. Program emphases are directed toward developing the information needed in order to obtain an early production commitment decision by management, and will be conducted in an environment consistent with production standards.

Preliminary development efforts were devoted to conceiving, developing and analyzing alternate design concepts and the preparation of a technical plan to aid in selecting and evaluating material, identifying ancillary structural development test requirements, and defining full-scale ground-test and flight-test requirements necessary to obtain FAA certification.

The program was built on precontract design activities as well as contracted design activities that consider:

- Program management and plans development
- Establishing design criteria
- Conceptual and preliminary design
- Manufacturing process development
- Material evaluation and selection
- Verification test
- Detail design
- FAA certification plan definition.

This report describes work accomplished during the first 3-month period of the contract as well as some precontract activities. These activities are described under the headings: Structural Configuration, Preliminary Design, Development Test Plans and Status, and Operations Development. The overall schedule status is summarized in Figure 1-1.

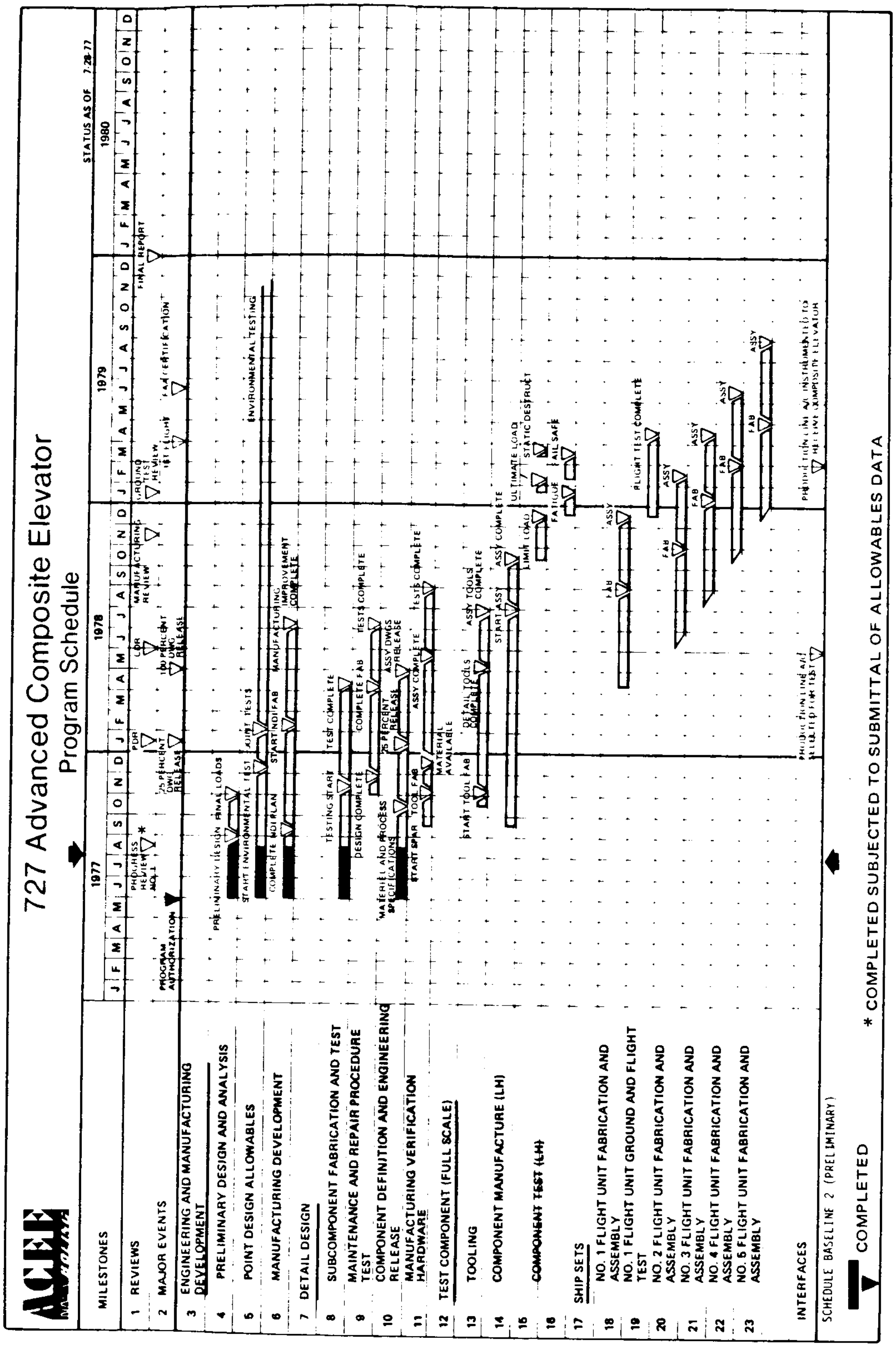


Figure 1-1 Program Master Schedule

SECTION 2

STRUCTURAL CONFIGURATION - EXISTING METAL ELEVATOR

The 727 elevators are aerodynamically balanced primary flight control surfaces located on the trailing edge of the horizontal stabilizer (Figure 2-1). Aerodynamic balance panels are located forward of the hinge line and are sealed to the stabilizer trailing edge structure. Mass balance weights are provided along balance panel piano hinges and at the horn on the outboard end to balance the elevator's structural weight aft of the hinge line. The elevator is hydraulically actuated with the capability of manual reversion in the event of hydraulic failure. The control tab on the elevator trailing edge is locked out except in the event of hydraulic failure. If failure

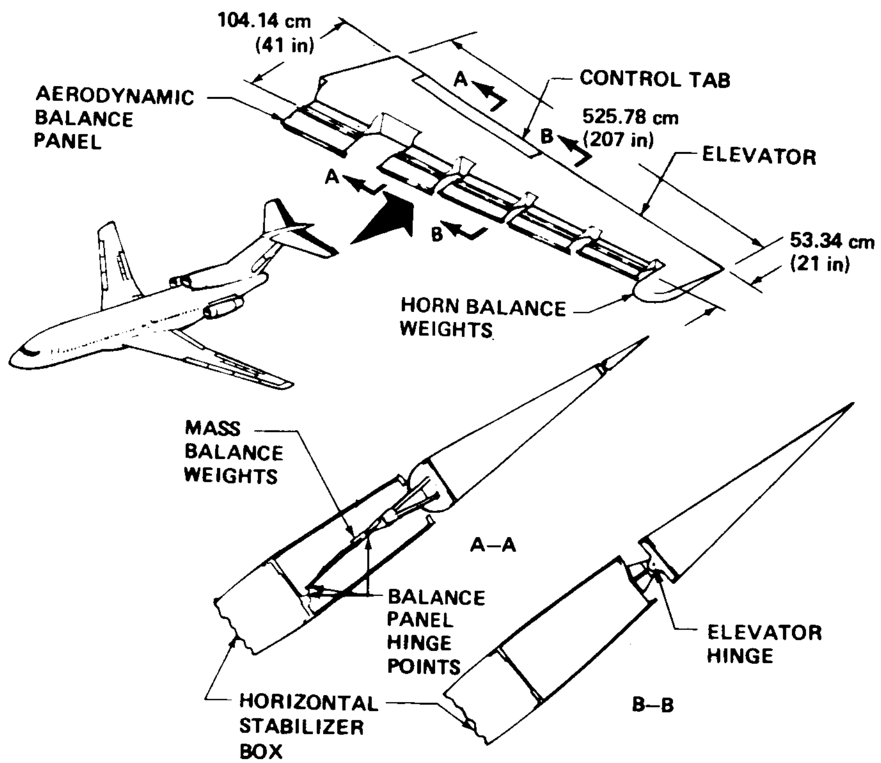


Figure 2-1 727 Elevator Configuration

occurs, tab movement provides the aerodynamic force required to operate the elevator. The elevator interfaces with the horizontal stabilizer along a piano hinge at the balance panel forward edge, and at the hinge fittings and actuator connections. These interfaces will be preserved to retain interchangeability. Figure 2-2 shows the structural arrangement with the entire structure composed of aluminum alloy, except for balance weights which are aluminum-bronze or stainless steel. Surface panels are bonded bead stiffened panels extensively segmented, while the ribs and spars are

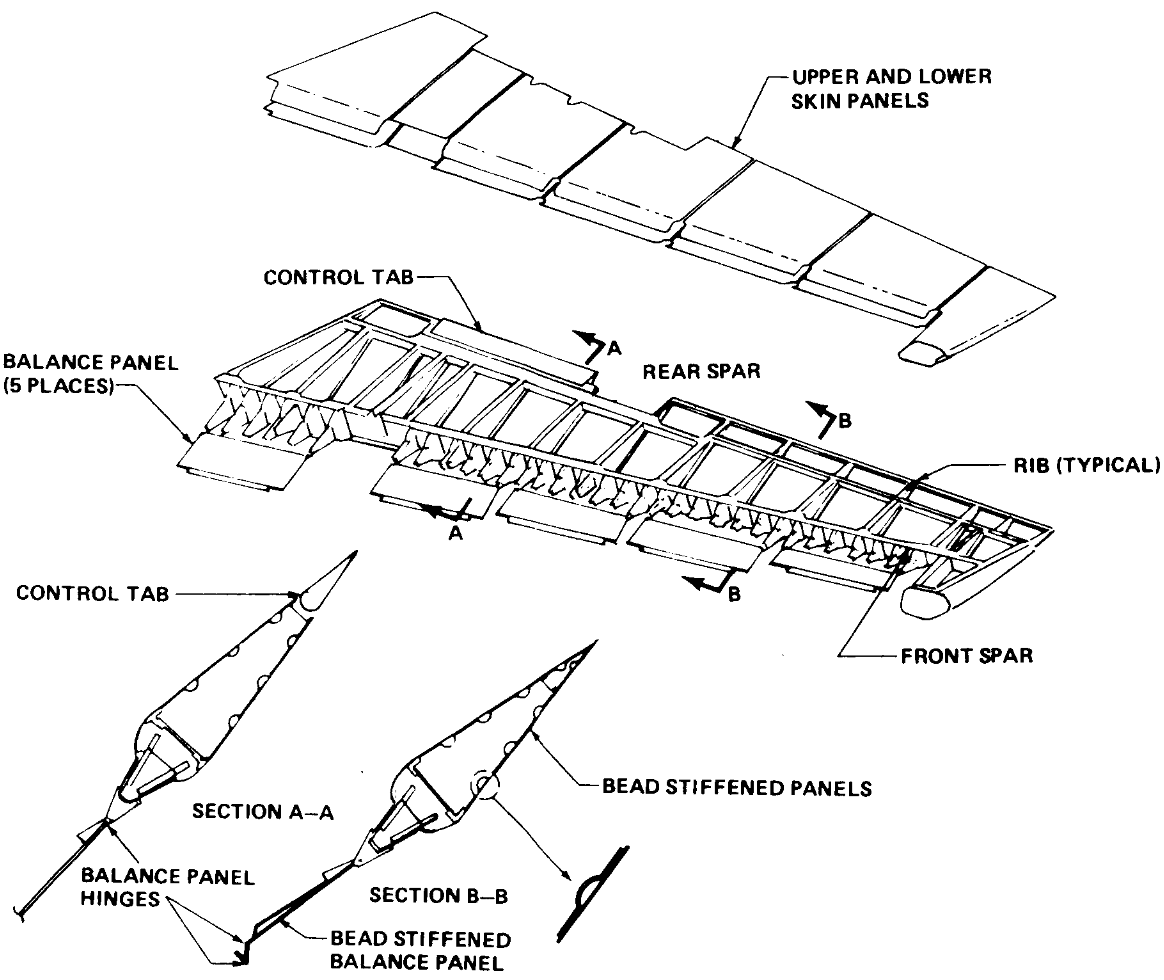


Figure 2-2 727 Nose Structure Arrangement built up by riveting stiffeners and chord members to webs (see Figure 2-3). The nose structure is comprised of 33 built up die formed ribs that support light skins and the aft balance panel hinge. Due to elevator taper, each rib is a different shape. The elevator structure is assembled by mechanical fasteners. The tab is a full- depth aluminum honeycomb structure with an extruded aluminum spar and is mounted to the elevator with five hinge fittings (see Figure 2-4).

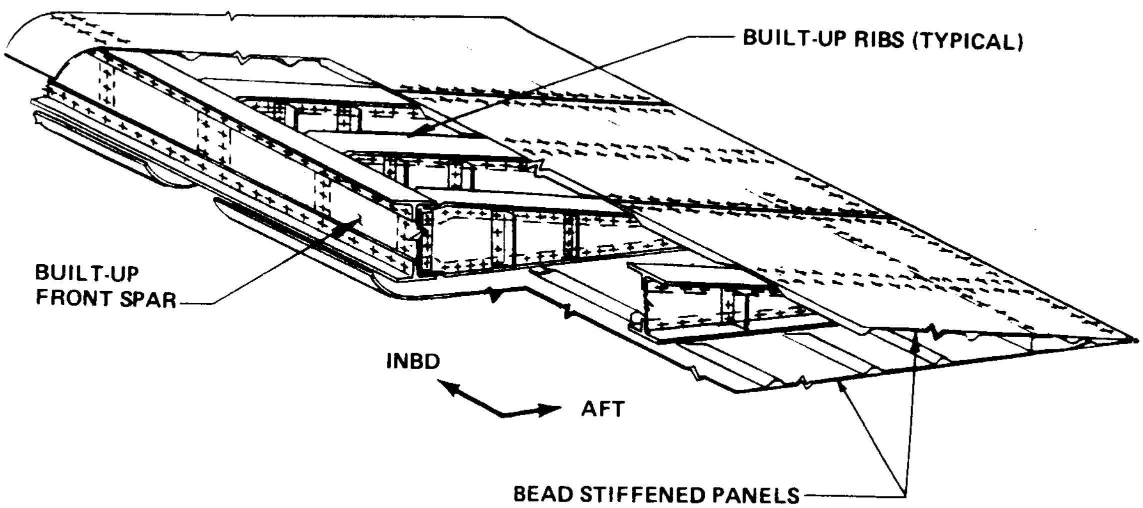


Figure 2-3 727 Aluminum Elevator Box

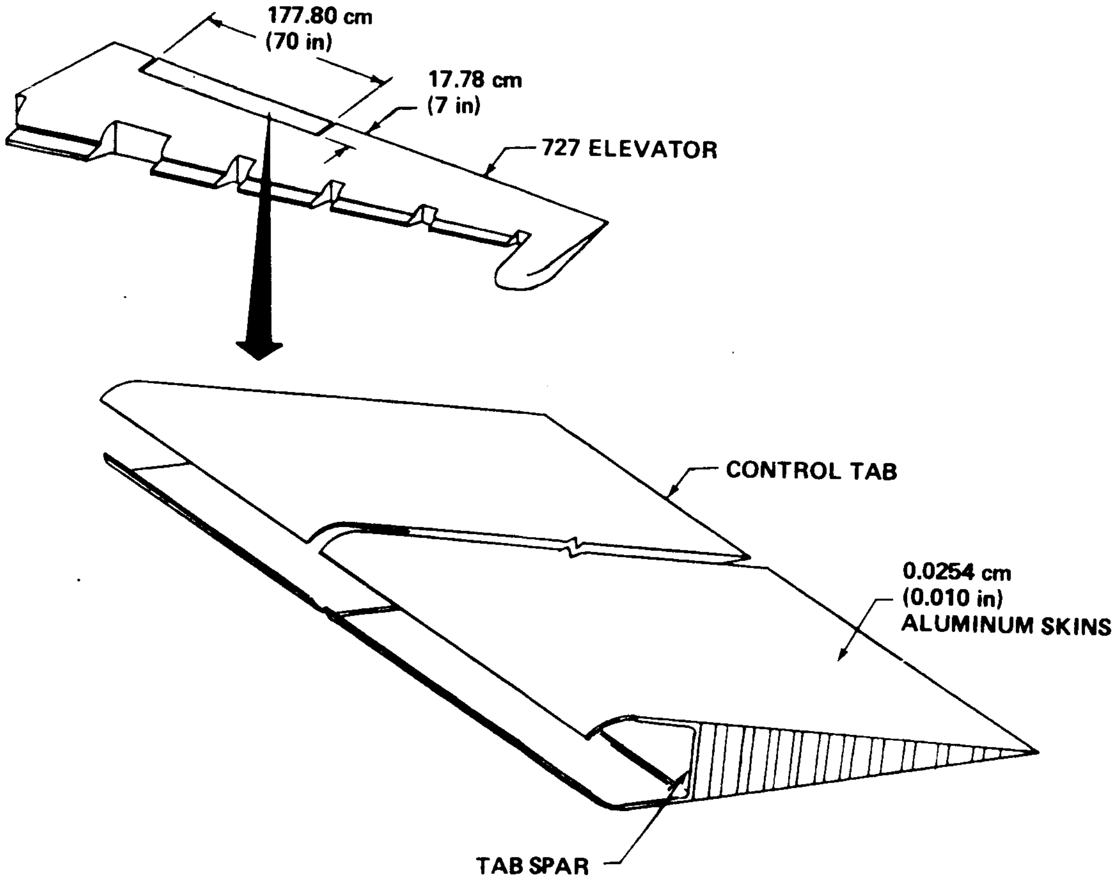


Figure 2-4 Aluminum Control Tab

SECTION 3

PRELIMINARY DESIGN

Preliminary design activities consisted of review and analysis of alternate design concepts relative to the baseline elevator design. This included trade studies in which durability, inspectability, producibility, repairability, and customer acceptance were evaluated.

3.1 DESIGN LOAD CRITERIA AND OBJECTIVE

3.1.1 Criteria and Objectives

The advanced composite elevators will be designed to meet the same criteria as the existing elevator. Both federal aviation regulations and Boeing requirements will be met. Additional criteria are as follows:

- The elevator must be interchangeable with existing elevators on all Model 727 airplanes and require no change to the horizontal stabilizer.
- The aerodynamic effectiveness of the elevator will not be significantly altered. This means the composite elevator stiffness must closely match the metal elevator stiffness, particularly in torsion.
- The composite elevator's strength, durability, inspectability and serviceability will be equal to or better than the existing metal elevator.
- Provisions for protection against damaging effects of lightning, static discharges and environmental elements will be provided.
- Structural bonding will not be used for joining major assemblies.

In addition to the preceding criteria, the following objectives have been established:

- The elevator weight will be reudced by a minimum of 20%
- All G/E parts to be co-cured.
- The recurring costs at the 200th unit will be equal to or less than that of the existing elevator at the 200th unit.

3.1.2 Loads

The elevator will be subsantiated for the highest loaded model 727 airplane. The requirements of the Federal Aviation Regulations (F.A.R.) and Boeing design specifications will be met. The load requirements include static limit and ultimate loads, durability, dynamics and vibration, and flutter. Federal Aviation Regulations include both positive and negative maneuver at the design dive speed (V_D). Additional Boeing conditions include a check maneuver and an instantaneous elevator. The F.A.R. limit load factor - velocity diagram is shown in Figure 3-1 for reference.

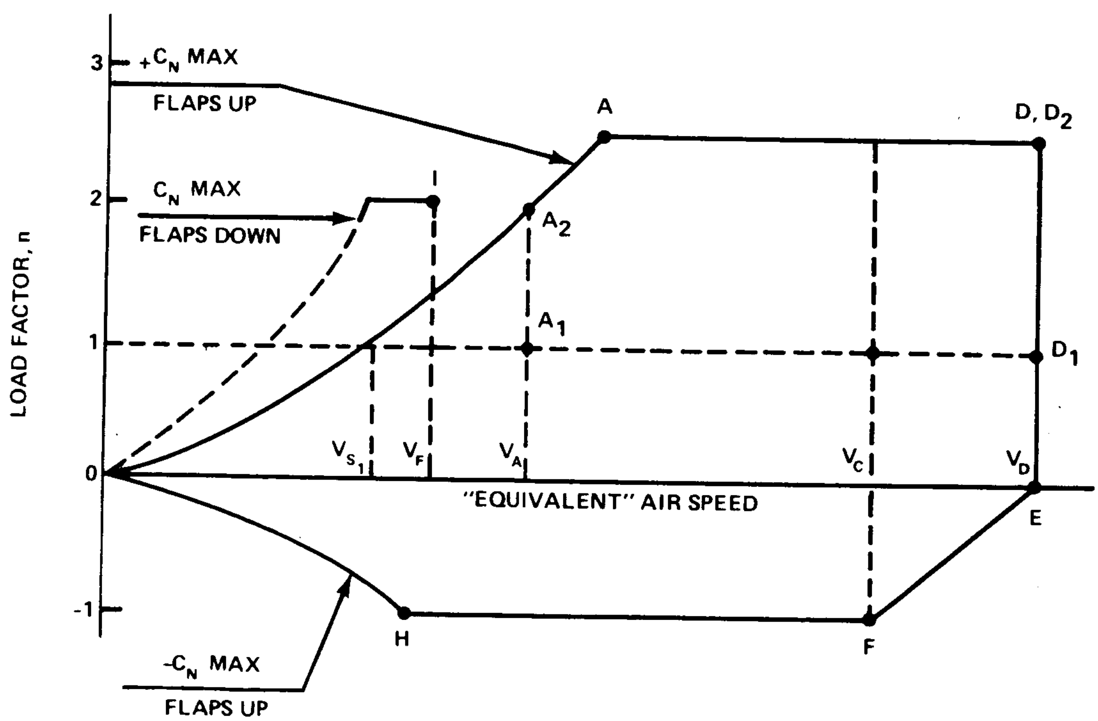
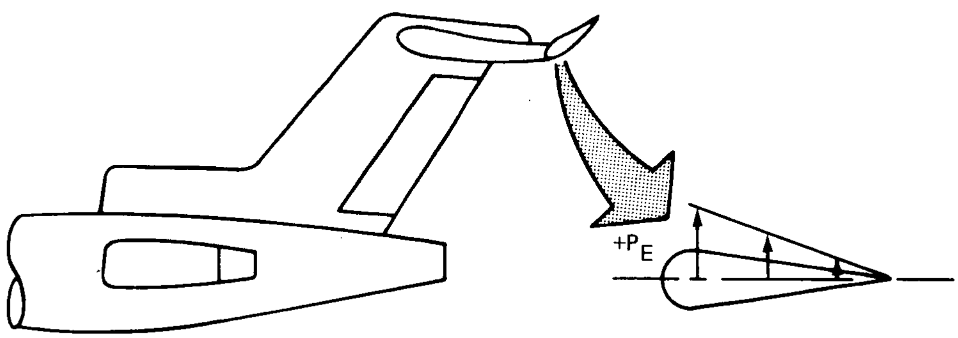


Figure 3-1 F.A.R. V-n Diagram

Critical design ultimate load (DUL) conditions are shown in Figure 3-2. The ultimate design pressures shown are the total lift pressure across the control surface.

Tension and compression strain (ε_T, ε_C) at the maximum DUL are approximately 0.0045 in./in. at the location shown in Figure 3-3. These strain levels occur at the end of the honeycomb panel ramp down as shown in the section view. These strains are primarily the result of panel pressure loads causing local bending at the edges. Maximum shear strains (γ) are



Condition	Limit load factor	Altitude, meters (feet)	Speed knots	Ultimate pressure P_E, KPa (psi)
+ Maneuver @ V_D	2.5	4145 (13,600)	460	−23.37 (−3.39)
−Maneuver @ V_D	−1.0	Sea level	390	23.31 (3.38)
Check maneuver	−1.0	Sea level	390	−2.76 (−0.40)
Instantaneous elevator	1.0	Sea level	250	−22.62 (−3.28)
+ Maneuver @ V_D	2.5	Sea level	460	−31.85 (−4.62)

Figure 3-2 Critical Design Conditions

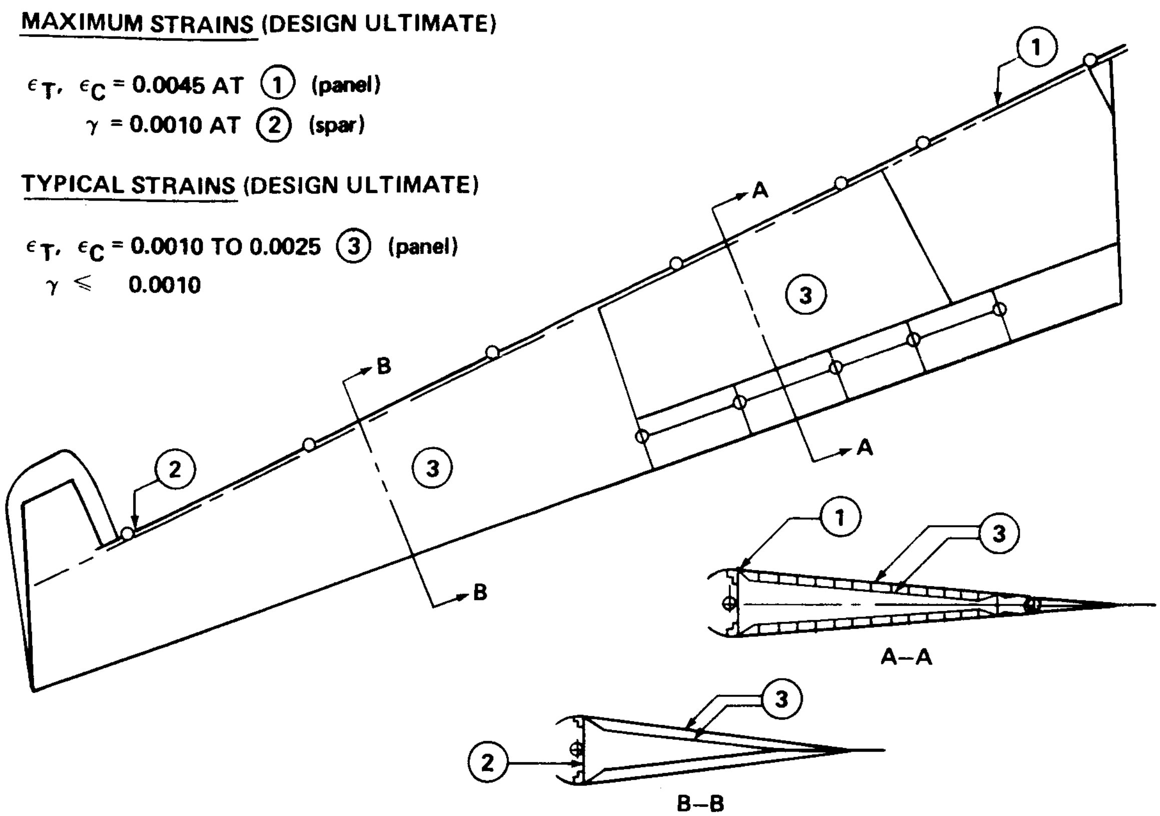


Figure 3-3 Elevator Strain Levels

approximately 0.0010 in./in. in the front spar web. Typical strains elsewhere are also shown. Actual test strains will be measured by instrumentation on subcomponent and the complete elevator box tests, as part of the Ancillary Test Program.

A finite element structural analysis model is in work and the analysis will be completed bo provide final loads prior to the formal design drawing releases. The analysis model will include the elevator and stabilizer structure, as well as the interface structure from the elevator to the stabilizer.

3.2 COMMON STRUCTURE

The existing nose structure consisting of nose ribs, nose skins, and aerodynamic balance panels will be retained with little or no change (see Figure 3-4). Changing this structure would not be cost effective and no significant weight savings would be achieved, because it is located forward of the elevator hinge line (i.e., for each pound of structures weight saved, a portion of that weight would have to be returned in balance weights to maintain the mass balance of the elevator). The aluminum actuator fitting is being retained with some minor machining changes because it is a complex fitting with critical interfaces for actuator attachment and hinge connections integrated into it.

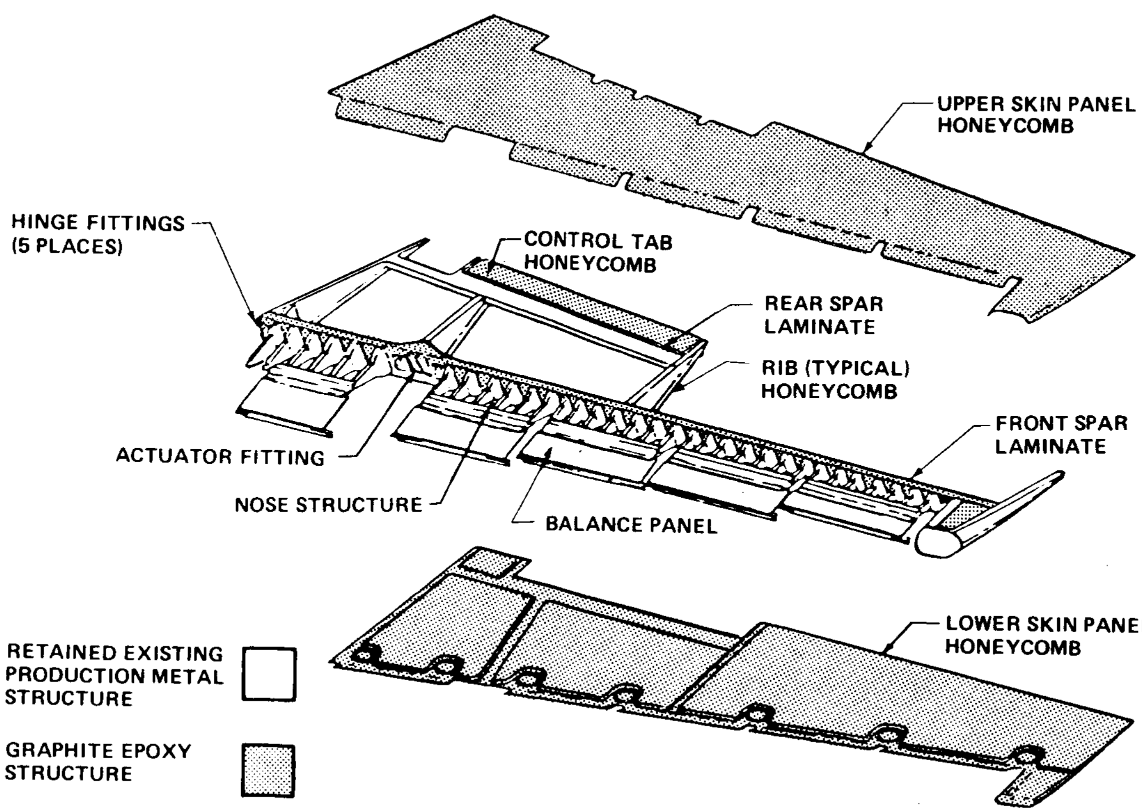


Figure 3-4 Composite Elevator Baseline Design

3.3 DESIGN STATUS AND TRADE STUDIES

The elevator preliminary design effort is essentially complete, and final configuration has been selected, and the detail design has begun. A strong desire by Boeing to obtain early production experience on advanced composite structure, combined with delays in contract award, has resulted in the preliminary design and development activity being well ahead of schedule. That portion of the precontract (Boeing funded) preliminary design effort necessary to show the design evolution to the selection configuration is included in this report. In order to take full advantage of Boeing production fiberglass experience and minimize program development risk, all concepts considered were assembled with mechanical fasteners.

The selected graphite/epoxy elevator configuration is shown in Figure 3-5. This design highlights one piece lightweight honeycomb upper and lower skin panels, laminate front spar spliced at actuator fitting, laminate rear spar from elevator tab inboard, and a minimum number of honeycomb ribs.

Figures 3-6, 3-7 and 3-8 show three other concepts that were considered, and a summary of this evaluation is shown on Table 3-1.

The results of this evaluation and the concept selected are consistent with the trends on recent Boeing commercial aircraft where fiberglass honeycomb panels are used extensively on lightly loaded control surfaces, including elevators. The selected concept is a refinement of an earlier concept which utilized existing hinge fittings and had ribs behind each elevator hinge. A study showed that redesigning the hinge fitting to introduce the overturning moment directly into the skin panels combined with elevator box triangular shape eliminated the need for distributing torsion loads to the panels by these ribs. Figure 3-9 shows the hinge fitting configuration.

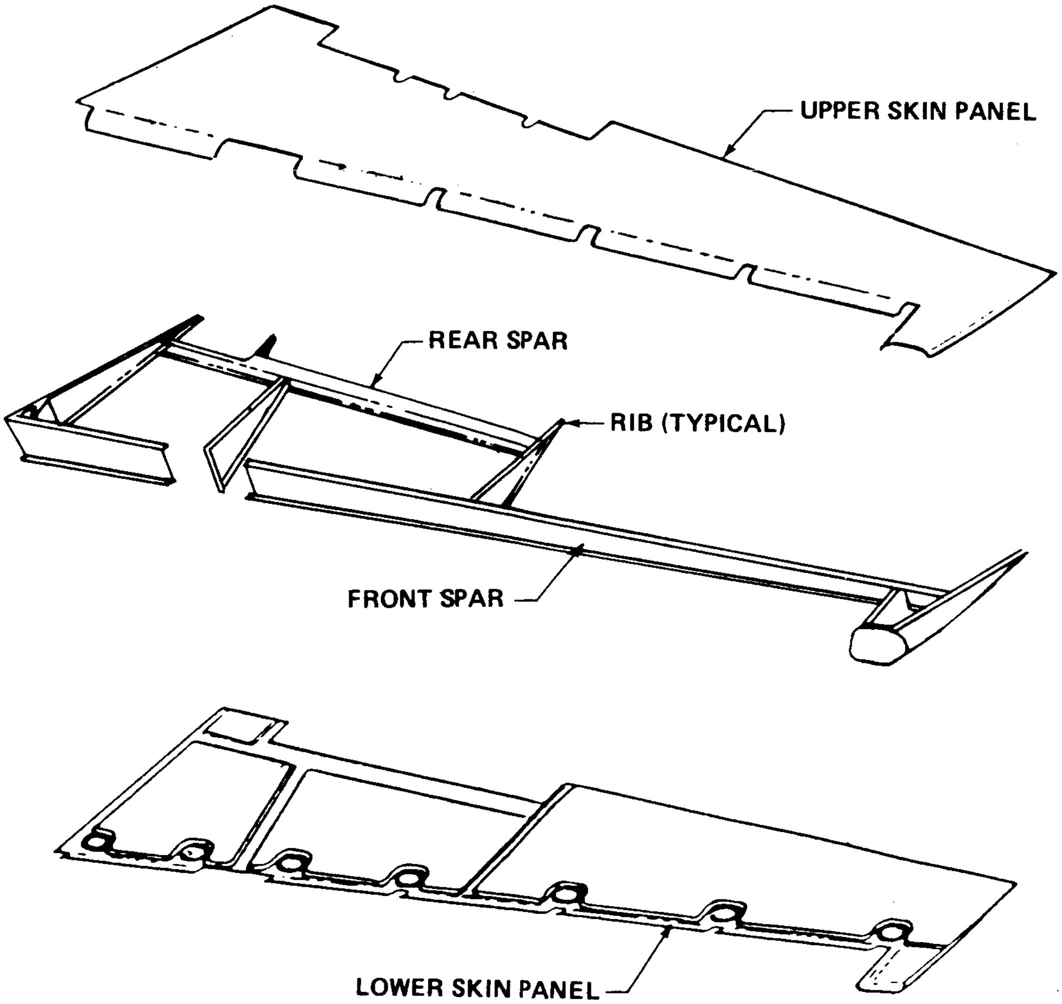


Figure 3-5 Minimum Rib Honeycomb Panel

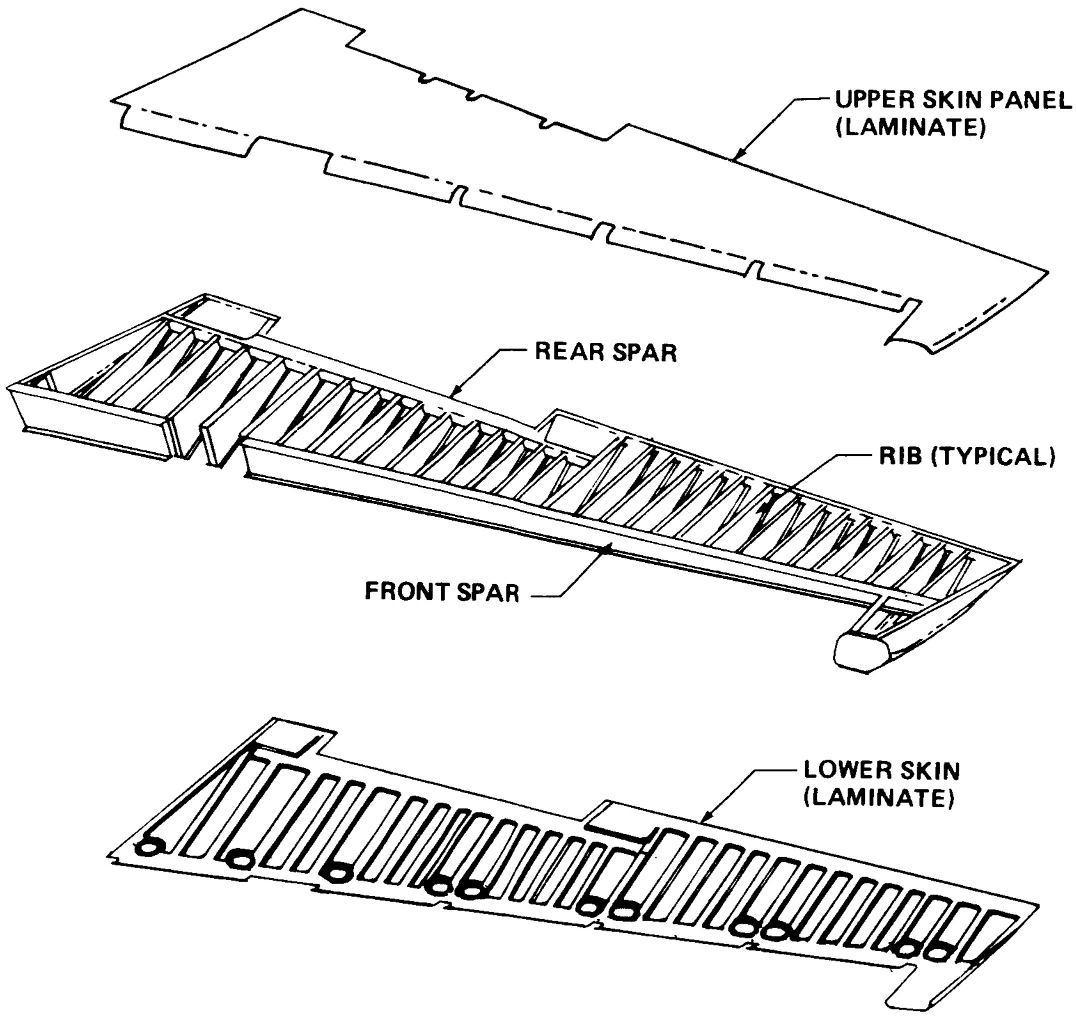


Figure 3-6 Multirib Unstiffened Panel

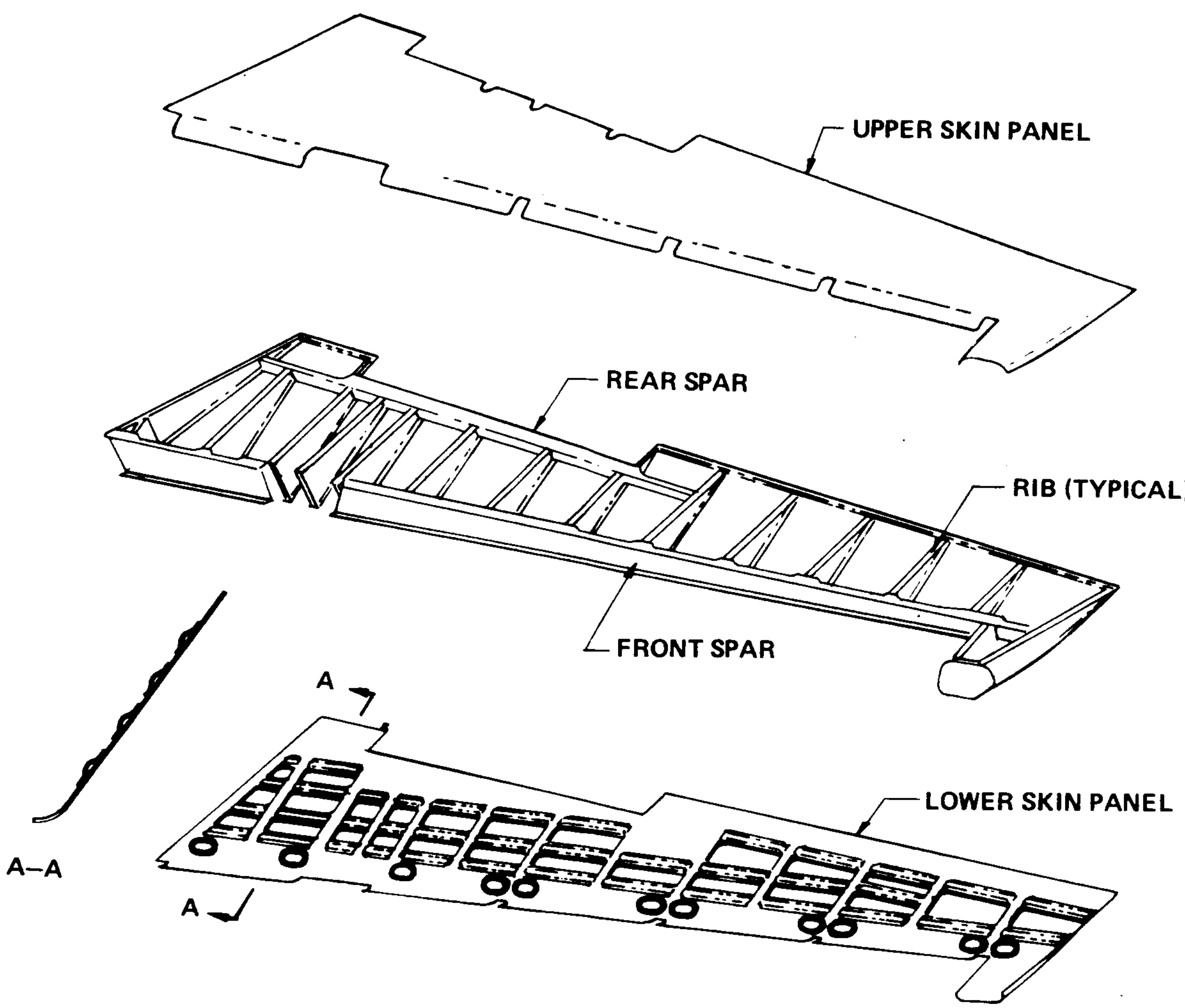


Figure 3-7 Bead Stiffened Panel

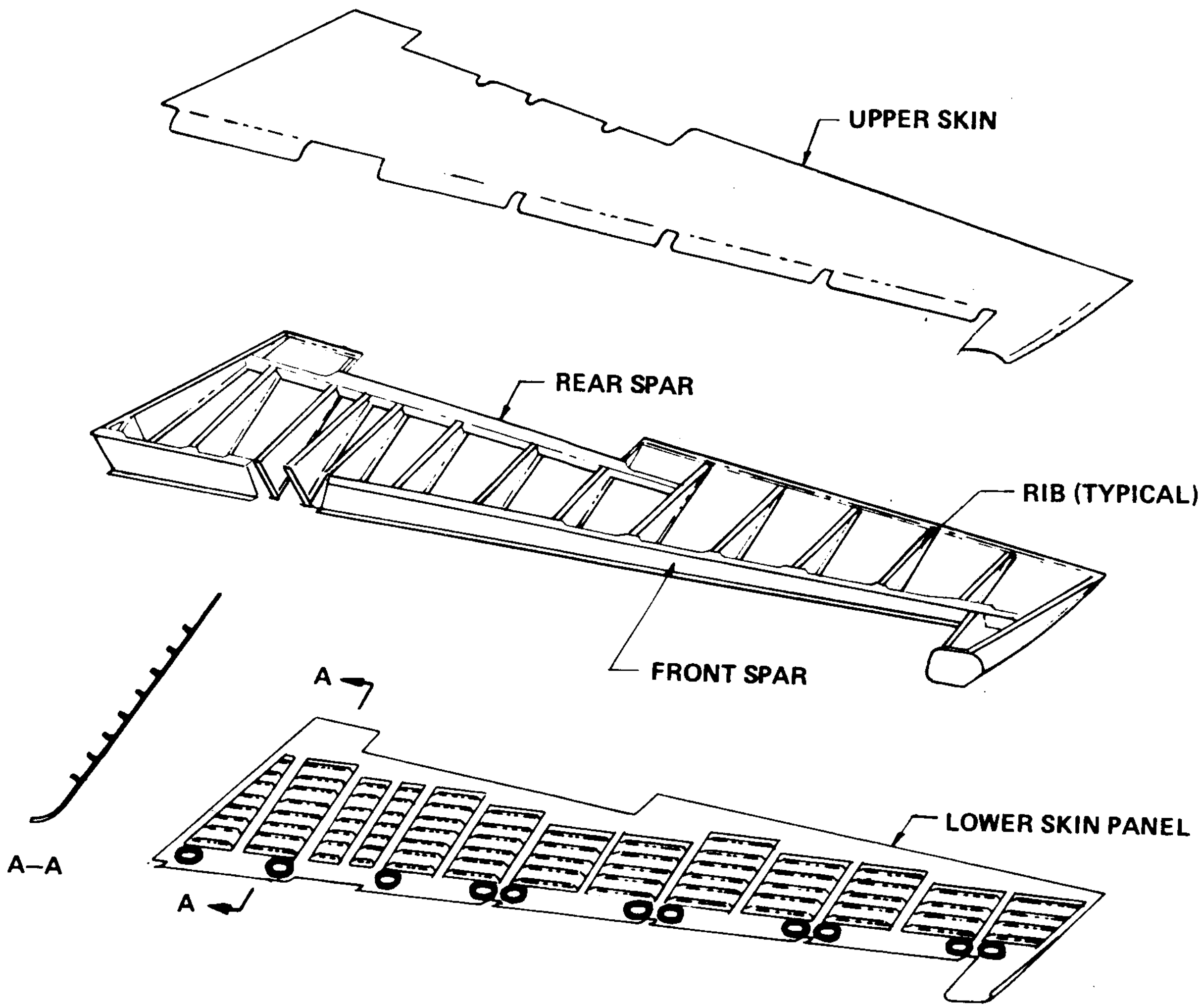


Figure 3-8 Blade Stiffened Panel

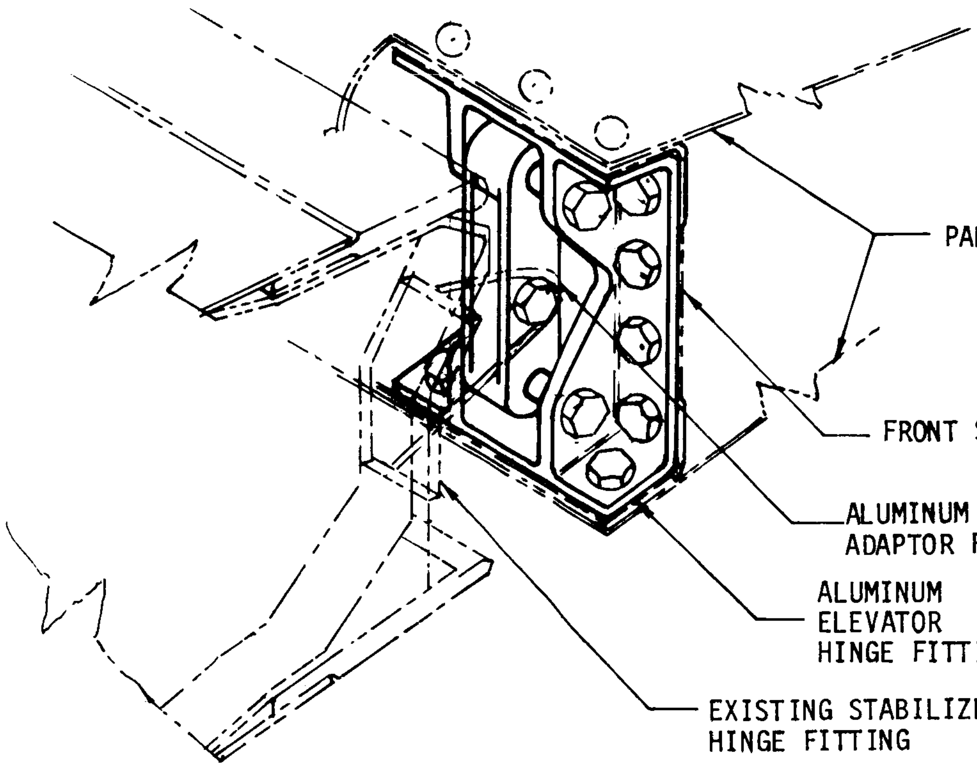


Figure 3-9 Sliding Block Hinge Fitting

Table 3-1 Concept Comparison

Concept	Rib Ratio	Fastener Ratio	Weight Ratio	Recurring Cost Ratio	Remarks
1. Minimum rib honeycomb panel design Figure 3-5	1	1	1	1	Simple panel tools
2. Multirib unstiffened panel design Figure 3-6	8.25	2.5	1.3–1.5	2.6	8 times the number of rib tools
3. Multirib bead stiffened panel design Figure 3-7	3.5	1.5	1.1–1.3	1.7	3.5 times the number of rib tools More complex panel tools Difficult to co-cure panels
4. Multirib blade stiffened panel design Figure 3-8	3.5	1.5	1.2–1.4	1.6	3.5 times the number of rib tools More complex panel tools

3.4 727 G/E ELEVATOR DESIGN DETAILS

3.4.1 Panels - Upper and Lower

Elevator panels are one-piece cocured honeycomb panels approximately 19 feet long. The basic panel is designed to provide the equivalent torsional stiffness as the existing aluminum panel and to carry the air pressure load without excessive deflection. A solid laminate for fastener attachment is provided along the front spar, trailing edge, rear spar ribs, and around cutouts (see Figure 3-10 for panel details). Before selecting layup configuration, several candidate layups were evaluated including fabrication of sample panels. The evaluation emphasized minimum weight, minimum layup time, smooth nonporous exterior surface to reduce finishing time, fiber

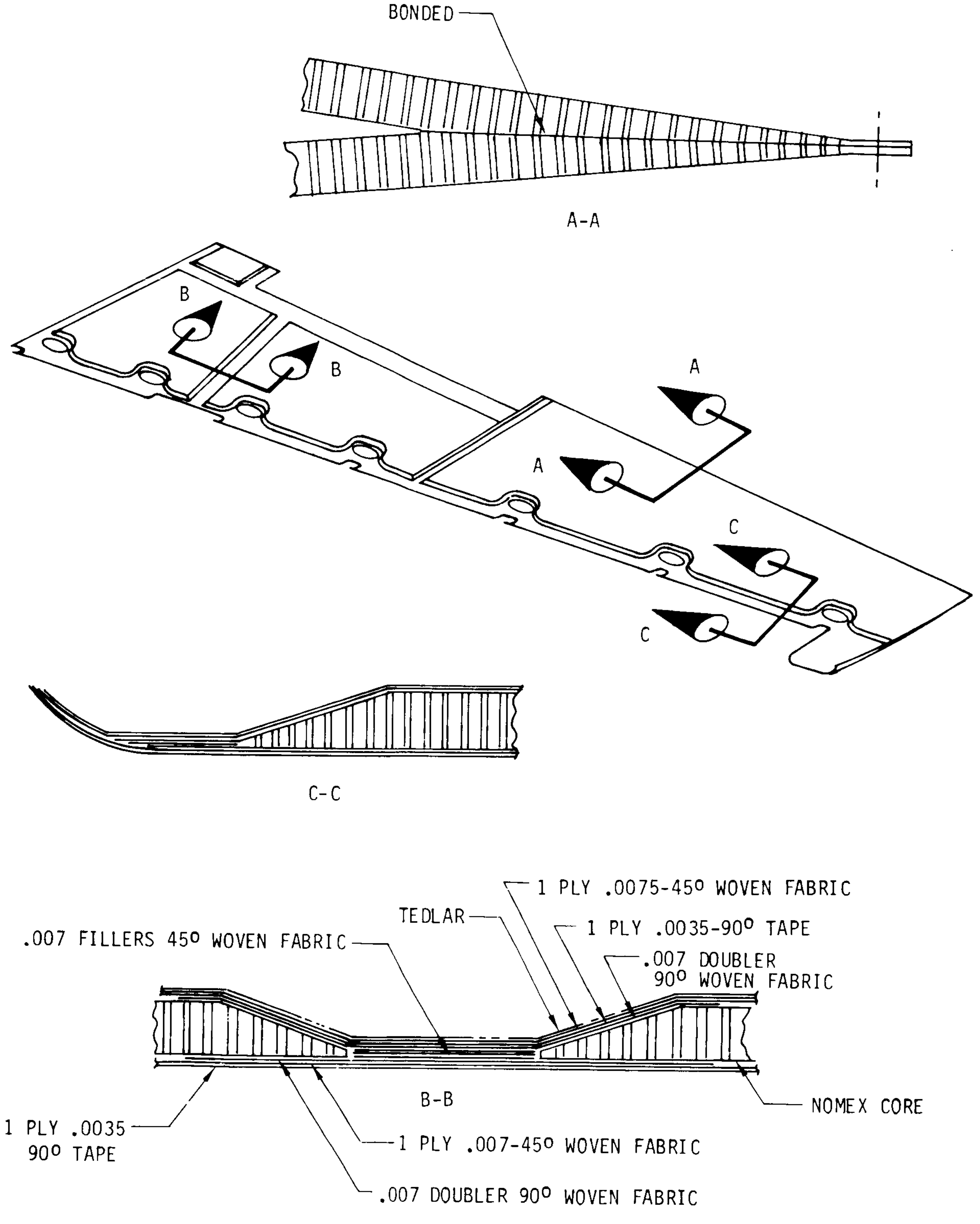


Figure 3-10 Graphite/Epoxy Skin Panel

breakout on exit side of holes, and panel warpage. A summary of the other candidate panel layups evaluated and relevant comments follow:

- Two plys of 0.007 woven fabric oriented $\pm 45^\circ$ and 0°, 90° on each side of core. 0° material is inefficient because it is not required to meet stiffness or strength requirements and adds weight. Exterior surface that is not smooth requires more finishing time.

- Four plys of 0.0035 tape in a 0°, $\pm 45^\circ$, 90° layup were evaluated in two forms of preplied broadgoods, namely, 2-ply (one $\pm 45^\circ$ and one 0°, 90°) and 4-ply (0, $\pm 45^\circ$, 90°). Both of these material forms indicated production problems as discussed in Section 5.1.3.

The selected layup configuration consisted of 0.0035 thick, 12-inch wide tape at 90° against tool and $\pm 45^\circ$ 0.007 thick woven fabric against core. The interior surface had 0.0035 thick, 12-inch wide tape at 90° against core and $\pm 45^\circ$ 0.007 thick woven fabric on bag side (see Figure 3-10). This layup resulted in panels of minimum weight (no 0° material), minimum cost (less G/E), and other production advantages as outlined in 5.1.5. All honeycomb panels have a 0.001 thick sheet of "tedlar" cocured on the interior surface (bag side) to provide a moisture barrier. All graphite prepreg used on the elevator will be Narmco 5208 low resin (no bleed) material. The adhesive system and core selected for honeycomb panel fabrication is 3M AF143 adhesive weighing 0.05 pounds per square foot and 1/8 cell, 3 pounds per cubic foot Nomex core. This is a cocuring 350°F adhesive with which Boeing has had considerable experience.

The exterior finish on these panels is the same as that presently used on production F/G panels, except the conductive coating used on fiberglass is not required on graphite. This finish system consists of a static conditioner (pinhole filler) and surfacer followed by primer and polyurethane enamel. Fiberglass service history has been very good with this system.

Laboratory comparative testing of this system shows fiberglass and graphite to be equivalent. With this background, we expect no significant finish system service problems.

A lightning protection system will be incorporated into the outboard 36 inches of the upper panel, as illustrated in Figure 3-11. A panel incorporating this system will be fabricated and lightning tested early in the program. The design objective for this system is to develop the capacity for withstanding normal intensity lightning strikes without structural damage.

3.4.2 Ribs

The four major ribs in the selected elevator design are minimum gage honeycomb ribs. The rib configuration and layup is defined in Figure 3-12. Prior to selecting this concept, a trade study was done comparing a honeycomb rib with a sine wave rib. Parts of each configuration were designed and fabricated. The ribs were of equal weight; however, the layup time for the sine wave configuration was substantially more than the honeycomb configuration (see Section 5.1.1 for further detail).

3.4.3 Front Spar and Rear Spar

The inboard and outboard front spars are channel-shaped laminates layed up on male tools. These spars are spliced by the actuator fitting. The layup consists of six plies of $\pm 45^{\circ}$ fabric with up to 11 plies of 0.0052 thick unidirectional tape interleaved with the fabric in the chord areas (Figure 3-13). The laminate spar section was selected because the stiffeners required for the 33 nose rib attachments plus the hinge fittings provide all the stiffening required. The chords are designed to provide the necessary bending stiffness, and the web is designed to carry the shear.

The rear spar is a closed channel-shaped laminate, layed up on a male tool that is split to permit removal of parts, as indicated in Figure 3-14. This spar ends at the outboard end of the tab and supports the five-tab

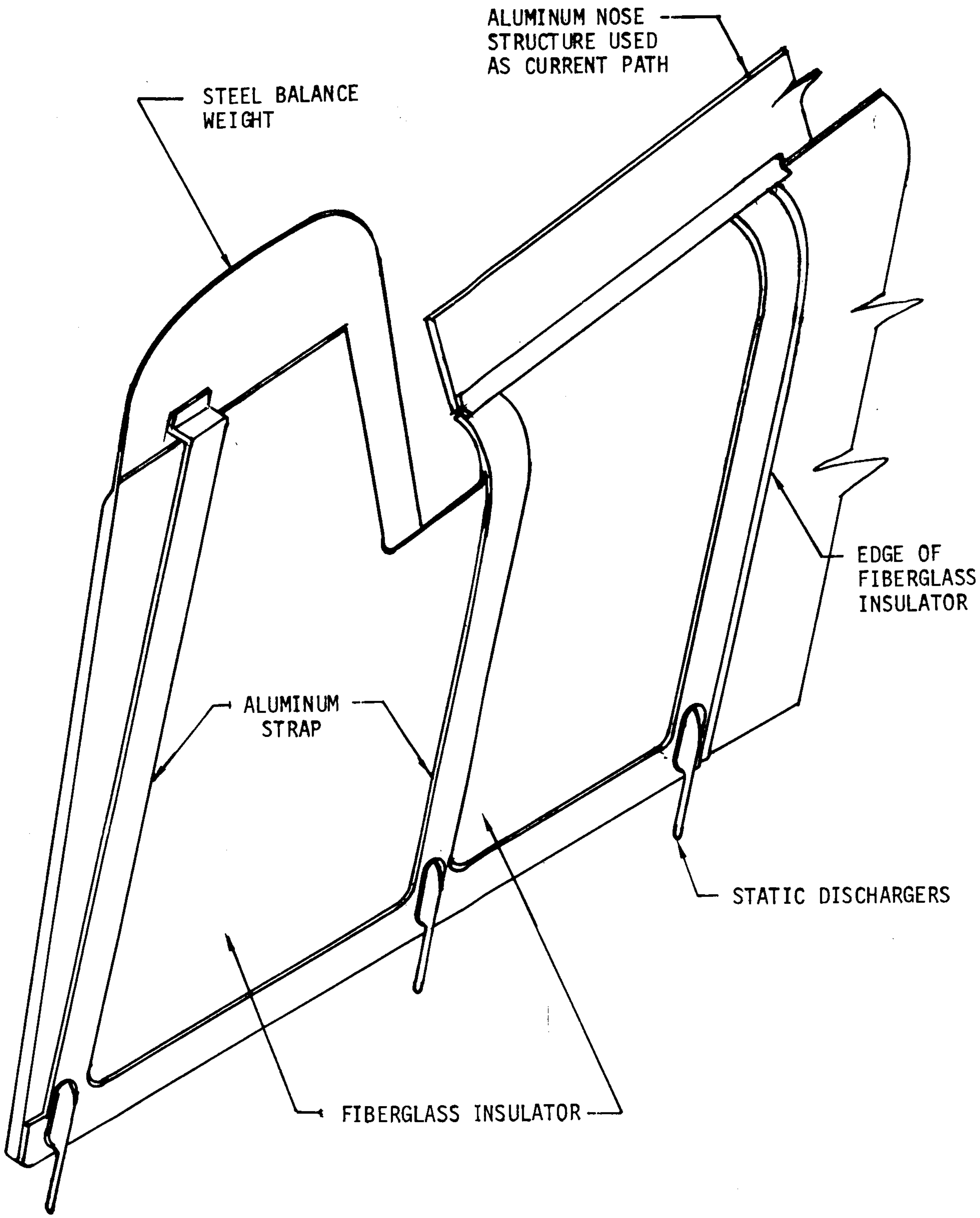


Figure 3-11 Lightning Protection

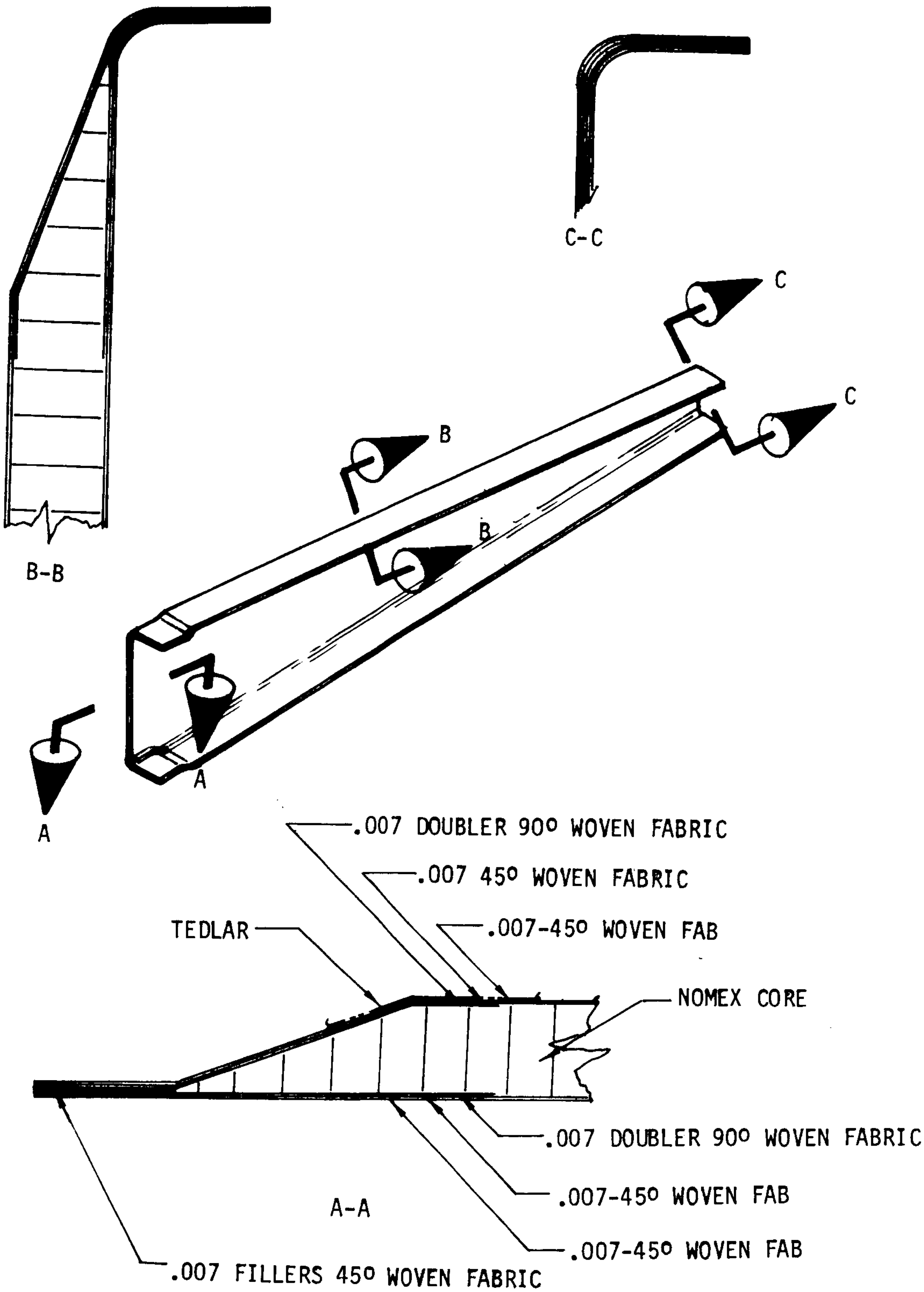


Figure 3-12 Graphite/Epoxy, Honeycomb Rib

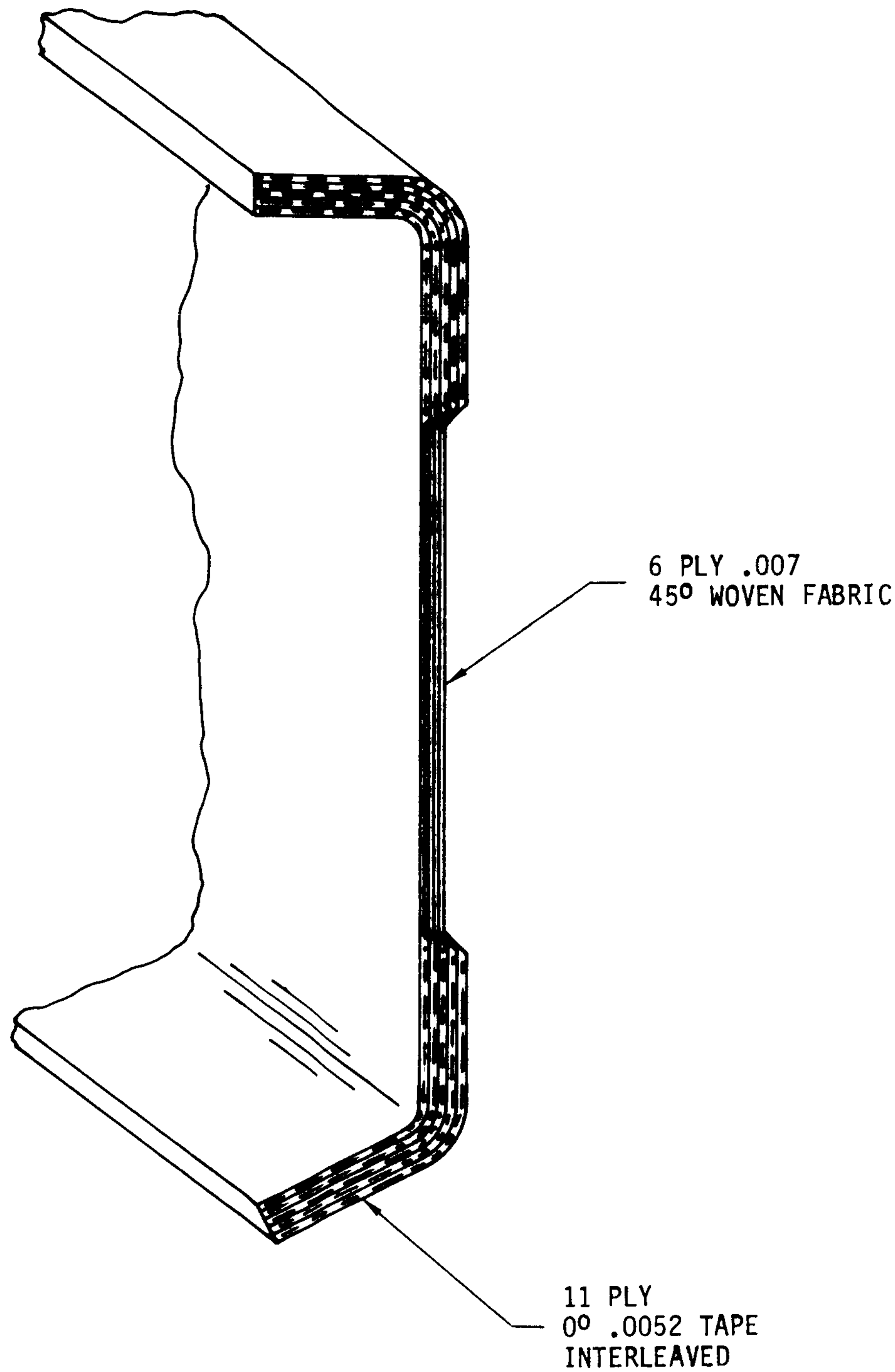


Figure 3-13 Front Spar

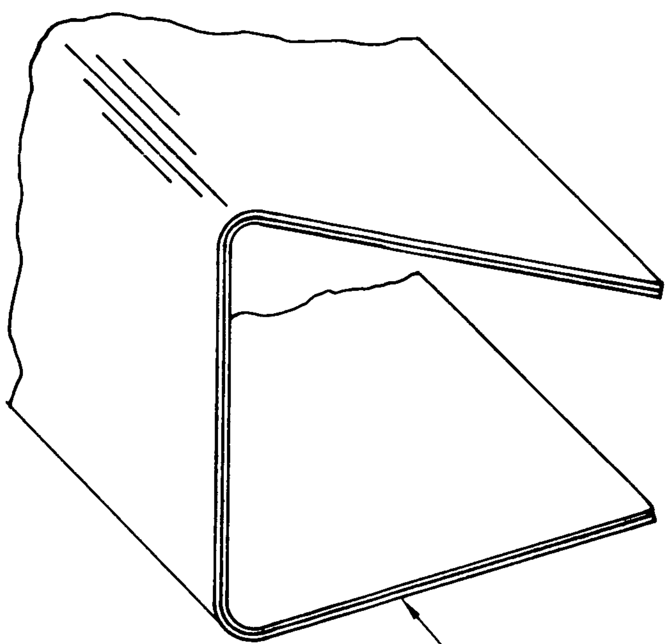


Figure 3-14 Rear Spar

hinge fittings and the aft edge of the elevator panels. One ply of 120 fiberglass is cocured with the G/E spars at aluminum to graphite interfaces to prevent corrosion.

3.4.4 Elevator Assembly

The assembly of the major elevator components is provided with titanium fasteners. Where access permits, titanium hi-loks are used, except along the outboard trailing edge where the panels are bonded and riveted together with a special harness-type double countersunk titanium rivet that is squeeze-installed. The adhesive used in the outboard trailing edge joint is a flexible room-temperature cure adhesive that will increase joint stiffness and seal the joint from moisture ingress. In limited access areas, titanium bolts and stainless steel nutplates are used.

3.4.5 Balance Weights

The existing elevator balance weights consist of a stainless steel casting positioned at the elevator-horn-tip, balance weights located at the aft edge of the balance panels, and aluminum-bronze balance panel hinges.

The lighter graphite/epoxy elevator will be mass balanced by removing all balance weights from the balance panels and reducing the weight of the aluminum-bronze hinges in those bays with the shorter balance arms.

3.4.6 Elevator Tab

The elevator tab is a light-weight G/E wedge-shaped structure with minimum thickness face sheets supported by full-depth 1/8 inch cell, 3 lb/ft^3 Nomex honeycomb core and a laminate spar (see Figure 3-15). Currently, the five aluminum hinge fittings are retained. One is relocated spanwise to preclude interchangeability with the current aluminum tab. Since elevators are mass-balanced control surfaces, only advanced composite tabs will be used on advanced composite elevators.

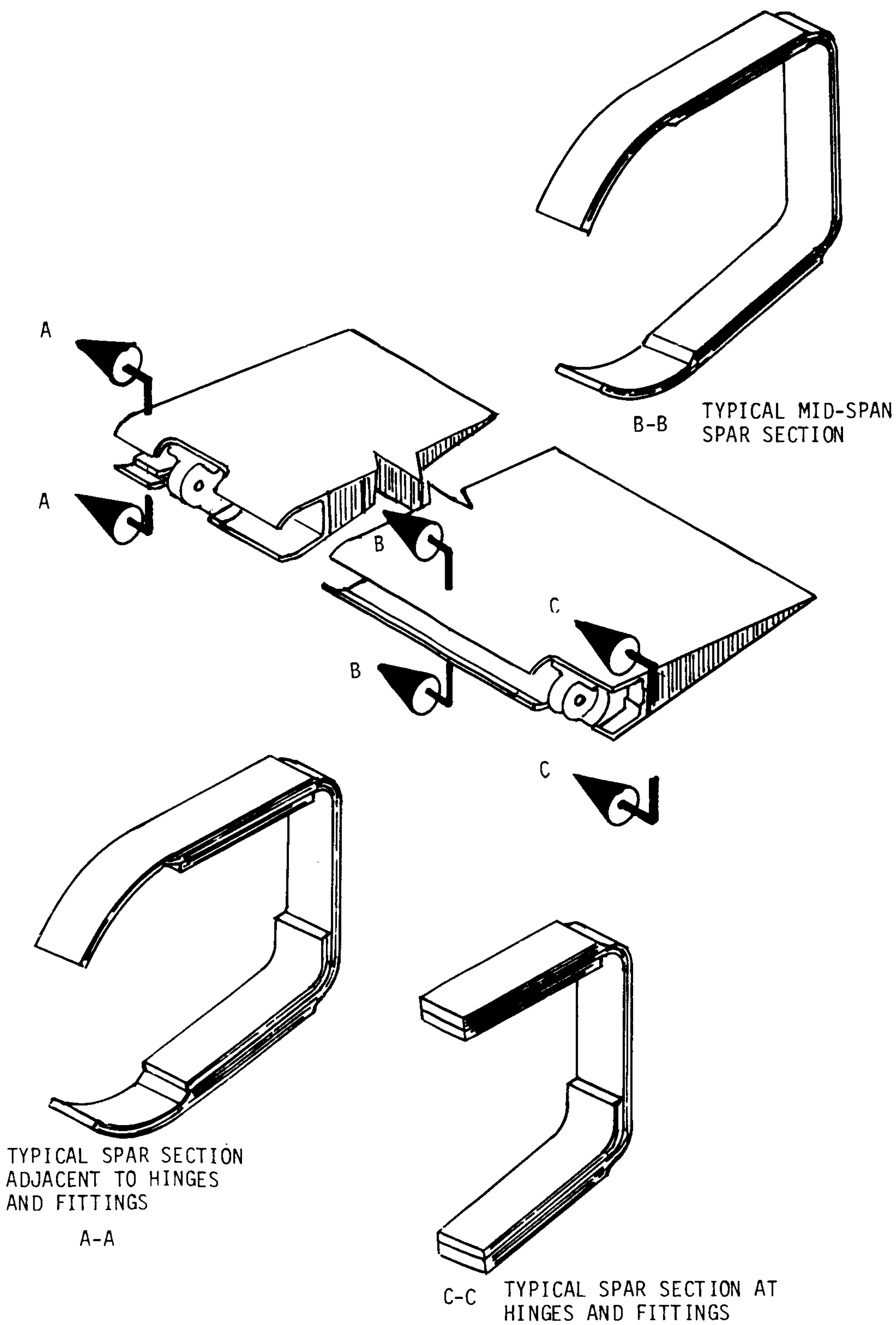


Figure 3-15 Graphite/Epoxy Tab

3.4.7 Thermal Considerations

Consistent with the current metal design, elevator side load is carried at the inboard end. Thermal expansion between the aluminum stabilizer and the G/E elevators builds up to a maximum at the outboard end where the total structural relative movement between the stabilizer and elevator can be 0.52 inches. This relative motion impacts the design in three areas.

1. Aerodynamic sealing of balance panels to the sides of the stabilizer hinge ribs--To maintain this seal throughout the elevator, operating temperatures require new larger diameter bulb seals and new seal retainers (see Figure 3-16).

2. The piano hinge between the balance panel and the elevator--The tight fit between the balance panel hinge halves prevents any spanwise motion. A new hinge is being designed that will permit enough space between the hinge halves to allow the required spanwise motion (Figure 3-16). Since this loose fit between hinge halves increases pin bending, a larger diameter hinge pin is required in the new design.

3. The elevator-to-stabilizer hinge connection--In order to provide the required spanwise motion in this area without any change to the stabilizer or stabilizer hinge fitting, two configurations were studied.
   - The first configuration involved increasing the distance between lugs to allow the required spanwise float, installing teflon-lined bushings on each side of stabilizer fitting, and changing the hinge pin to a higher heat-treat steel pin, as shown in Figure 3-17.

   - The second concept involved the introduction of an adaptor fitting that retains the existing hinge pin by providing lugs identical to the existing elevator hinge fitting and transferring the spanwise motion to bolts above and below the hinge point (see Figure 3-9 for configuration details).

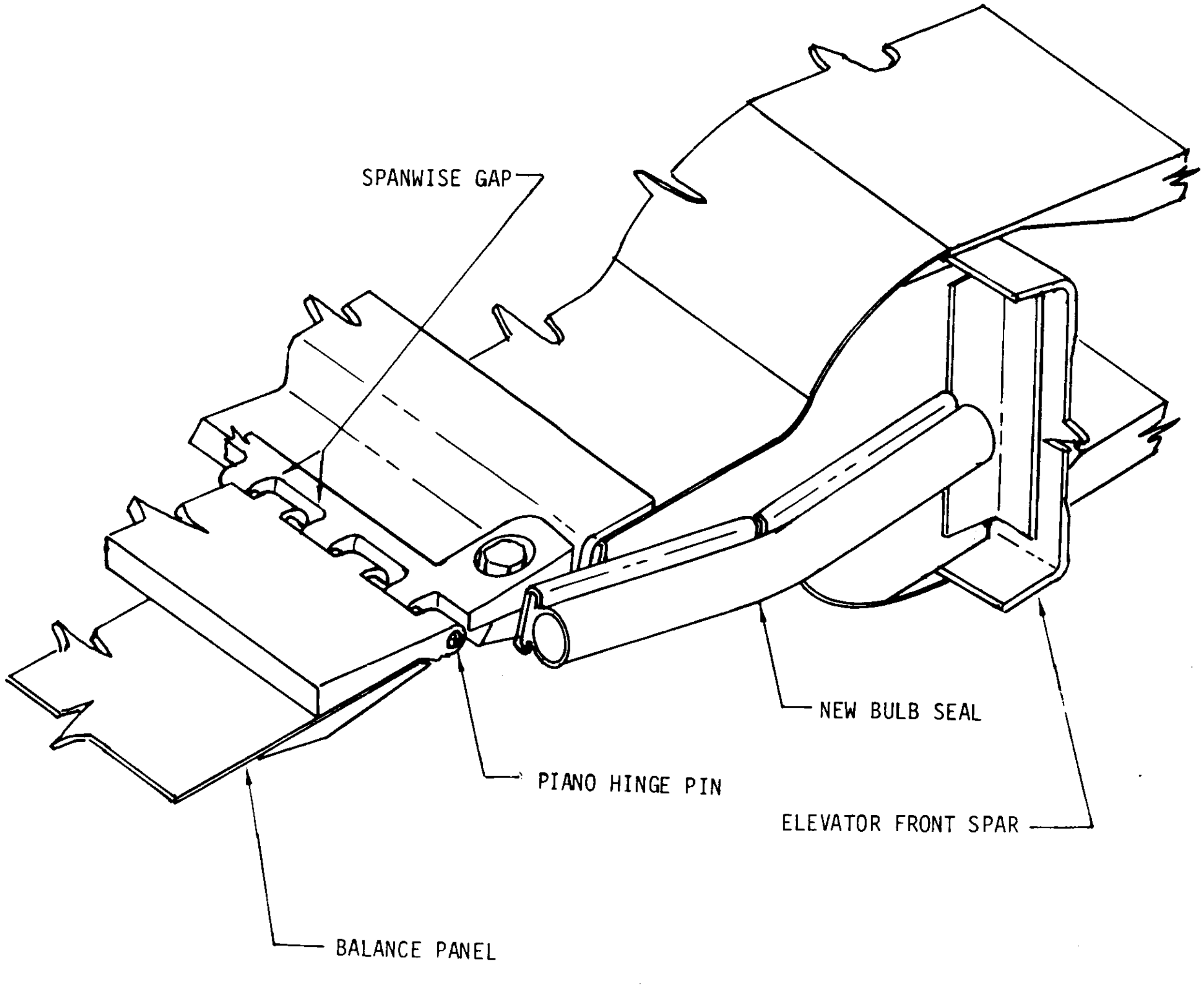


Figure 3-16 Adjustable Seals and Piano Hinge

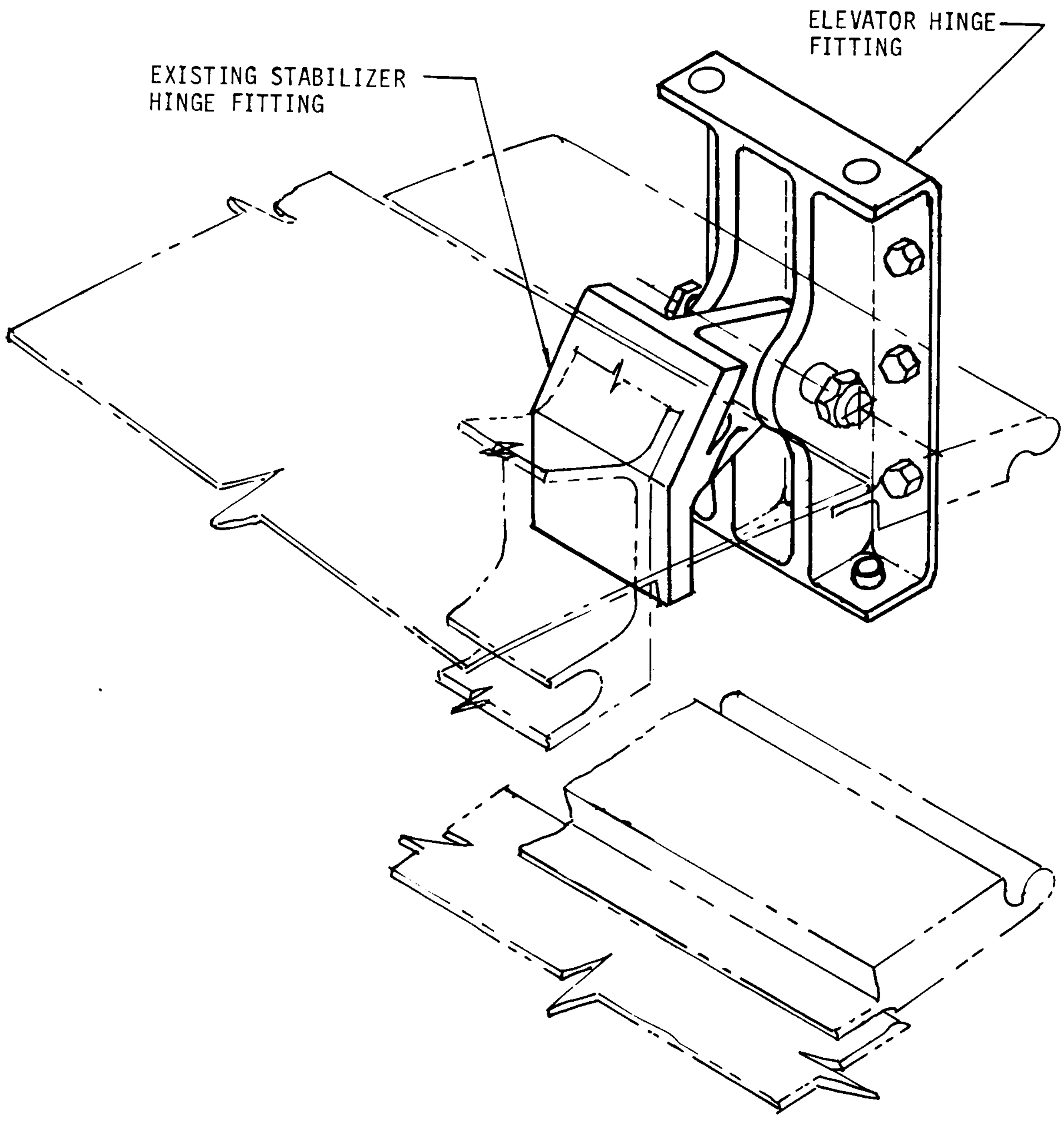


Figure 3-17 Verification Test Box

Mock-ups were made of each of these configurations for detailed evaluation of access, producibility, and maintainability. This evaluation led to the selection of the concept that incorporates the adaptor fitting. This concept provided for considerably better access for elevator installation and/or removal, and avoided the use of a special high-heat-treat hinge steel bolt at a point of interchangeability.

3.5 Design Summary

Boeing enters into the design of the selected elevator concept with a high degree of confidence. This confidence is based upon our extensive experience in the production of fiberglass honeycomb for similar configurations, and a preliminary verification test of the structural integrity, stiffness, and producibility of this concept on a precontract test box. This test article shown in Figures 3-18 and 3-19 represented a 4-foot section of elevator. Critical ultimate load conditions for the front spar and panels were applied at room temperature, $-65^{o}F$ and $+150^{o}F$ without any structural damage or permanent set. The test article was further loaded until the panels experienced 180 percent ultimate shear while carrying ultimate pressure, and the spar was loaded to 125 percent ultimate shear. The torsional stiffness of the box very closely matched the calculated value and was not significantly affected by the extreme temperature.

3.6 WEIGHTS STATUS

The following design changes resulted in a substantial weight reduction for the elevator. See Table 3-2 for comparison of the existing aluminum design and the proposed graphite epoxy design.

3.6.1 Front Spar

The front spar construction has been changed from aluminum upper and lower tee chords, web, and stiffeners to a channel section laminated graphite

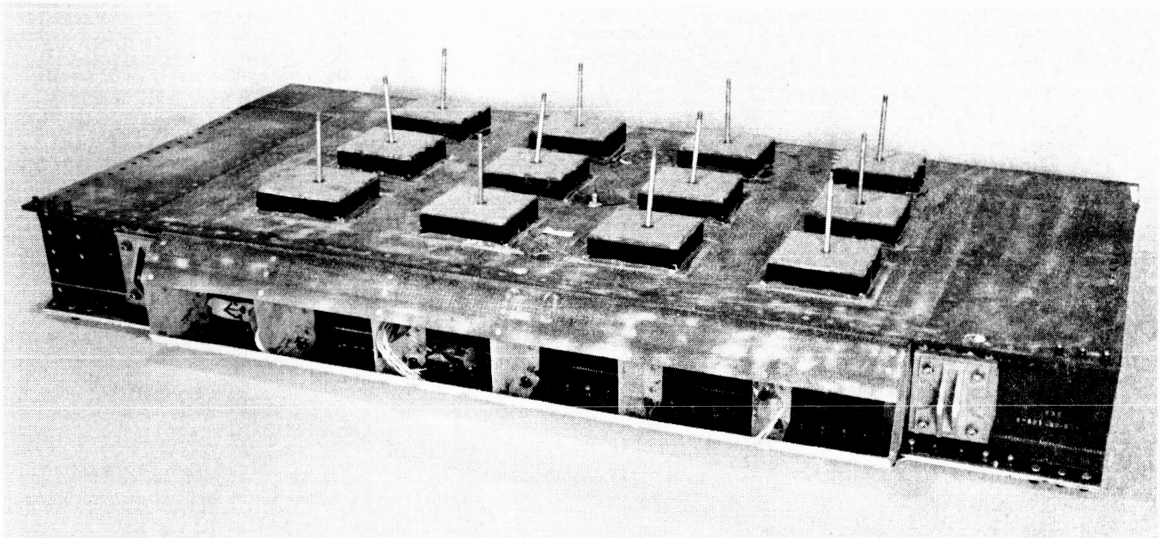


Figure 3-18 Verification Test Box

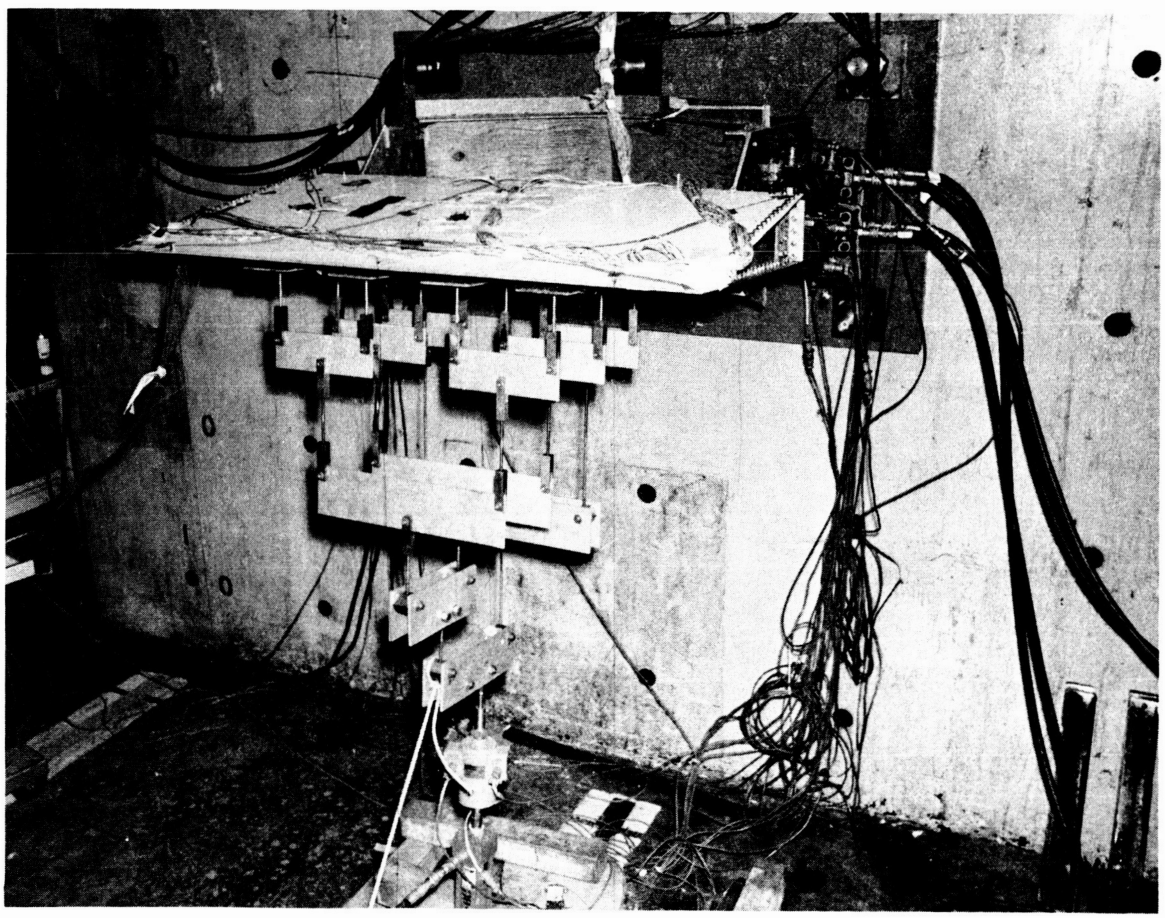


Figure 3-19 Verification Test Box Loading

Table 3-2 Model 727-200 Advanced Composite Elevator Weight Comparison

Elevator Component	Current Elevator Weight kg (lb)/ Airplane	Composite Design Weight kg (lb)/ Airplane	Weight Saving kg (lb)/Airplane	Percent Saving
Front and rear spars	171.3 (77.7)	127.9 (58.0)	−43.4 (−21.6)	25
Ribs	58.6 (26.6)	34.4 (15.6)	−24.2 (−12.0)	41
Skin panels	256.4 (116.3)	213.4 (96.8)	−43.0 (−19.5)	17
Control tab	53.8 (24.4)	36.8 (16.7)	−17.0 (−7.7)	32
Horn structure	29.1 (13.2)	17.6 (8.0)	−11.5 (−5.2)	39
Replaced structure	569.2 (258.2)	430.1 (195.1)	−139.1 (−63.1)	24
Balance panel weight	155.6 (70.6)	(0)	−155.6 (−70.6)	100
Balance panel hinges	265.2 (120.3)	198.4 (90.0)	−66.8 (−30.3)	25
Revised balance weights	420.8 (190.9)	198.4 (90.0)	−222.4 (−100.9)	53
Nose ribs and skins	82.0 (37.2)	82.0 (37.2)	–	0
Balance panel structure	77.6 (35.2)	77.6 (35.2)	–	0
Horn balance weight	91.5 (41.5)	91.5 (41.5)	–	0
Common structure	251.1 (113.9)	251.1 (113.9)	(0)	0
Total elevator	1241.1 (563.0)	879.6 (399.0)	−361.5 (−164.0)	29

1 lb = 2.2046 kg

epoxy structure. The front spar comprises an inboard and outboard section joined by the existing actuator fitting. Also included in the front spar's weight are elevator hinge halves.

3.6.2 Rear Spar

The existing aluminum channel section rear spar runs from the inboard closure rib to the outboard closure rib. The graphite epoxy laminated channel section rear spar runs from the inboard closure rib to elevator station 118.0. The rear spar weight includes the tab hinge halves.

3.6.3 Ribs

The existing aluminum elevator contains 13 major ribs, each having upper and lower tee chords and web. The composite elevator design contains four major ribs. The composite ribs are honeycomb web construction of channel section.

3.6.4 Skin Panels

The existing aluminum skin panels are of a bonded skin and beaded doubler construction with additional doublers at rib and spar chord areas. This is changed in the graphite epoxy design to a honeycomb sandwich skin panel with one ply of fabric and one ply of tape per face sheet. Doubler plies are added in the areas of attachments to ribs and spars.

3.6.5 Control Tab

The existing aluminum honeycomb, aluminum face sheet wedge-shaped tab is changed to a Nomex honeycomb, graphite epoxy face sheet tab of the same geometric shape. The reduction in weight of the tab enables the tab balance weights also to be reduced.

3.6.6 Horn Structure

The existing horn structure comprises an outboard closure rib, an inboard rib, an inspar rib, and a transverse rib. The composite horn structure deletes the inspar rib and replaces the remaining ribs with graphite epoxy ribs with honeycomb webs.

3.6.7 Balance Panel Weights

The reduction in weight of the elevator structure aft of the hinge centerline enables the deletion of all the elevator balance panel weights forward of the hinge centerline.

3.6.8 Balance Panel Hinges

In addition to the total deletion of the balance panel weights, it was also possible to reduce the weight of the balance panel hinges in the balancing of the elevator.

3.6.9 Common Structure

All items listed under common structure (Figure 3-20) are components of the existing elevator design which are reused on the advanced composite design elevator.

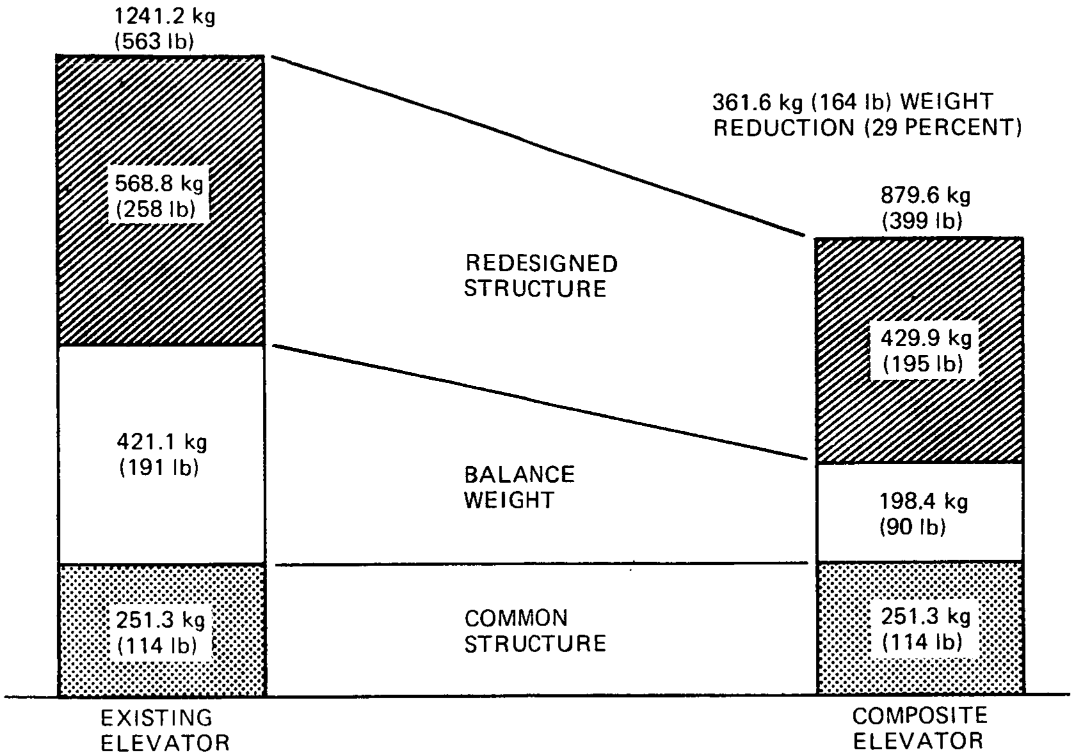


Figure 3-20 Projected Elevator Weight Reduction

SECTION 4

DEVELOPMENT TEST PLANS AND STATUS

Preliminary Boeing funded development efforts were devoted to preparation of a technical plan to aid in selecting and evaluating material, identifying ancillary structural development test requirements, and in defining full-scale ground test and flight test requirements necessary to obtain FAA certification.

4.1 MATERIAL EVALUATION AND SELECTION

Graphite/epoxy composite prepreg system selection and evaluation included the following materials, tests, and manufacturing considerations. In addition, an evaluation of material history and current industry usage was made.

4.1.1 Tests

The systems selected for testing were:

System	Supplier
T300/5208	NARMCO
T300/5235	NARMCO
T300/934	FIBERITE
T300/976	FIBERITE
AS/3501-5A	HERCULES
T300/F263	HEXCEL
T300/F288	HEXCEL

Each system was ordered and tested in the following forms:

- 3.5 mil 2-ply preplied tape
- 5.2 mil unidirectional tape
- 7.0 mil plain weave fabric prepreg

Prepreg forms were ordered for the general requirements of XBMS8-212 with specific tolerances on prepreg and cured laminate physical properties. Testing included:

- Resin
  - Differential scanning calorimetry (DSC)
  - Liquid chromatography (LC)
  - Thermal gravimetric analysis (TGS)

- Prepreg
  - Resin content, percent of weight
  - Volatile content, percent of weight
  - Resin gel time, minutes
  - Resin flow, percent of weight
  - Graphite areal weight

- Laminate Properties
  - Fiber volume
  - Density, thickness/ply, void content
  - Weight
  - Tensile/modulus
  - Short beam shear

- Sandwich Properties
  - Flatwise tension
  - Porosity
  - Peel
  - Weight

4.1.2 Manufacturing Producibility

A test panel (Figure 4-1) representing typical layup complexity on actual structure was fabricated under production shop operations. Drape, tack, work time, and degree of difficulty in layup were determined for each material system and form. Quality Control performed receiving inspection tests on all materials used in the evaluation. They also made a thorough comparison of suppliers' certified test data and Boeing's test results. In all instances the suppliers' test data and Boeing's test results compared favorably within very close limits.

4.1.3 Material Selection

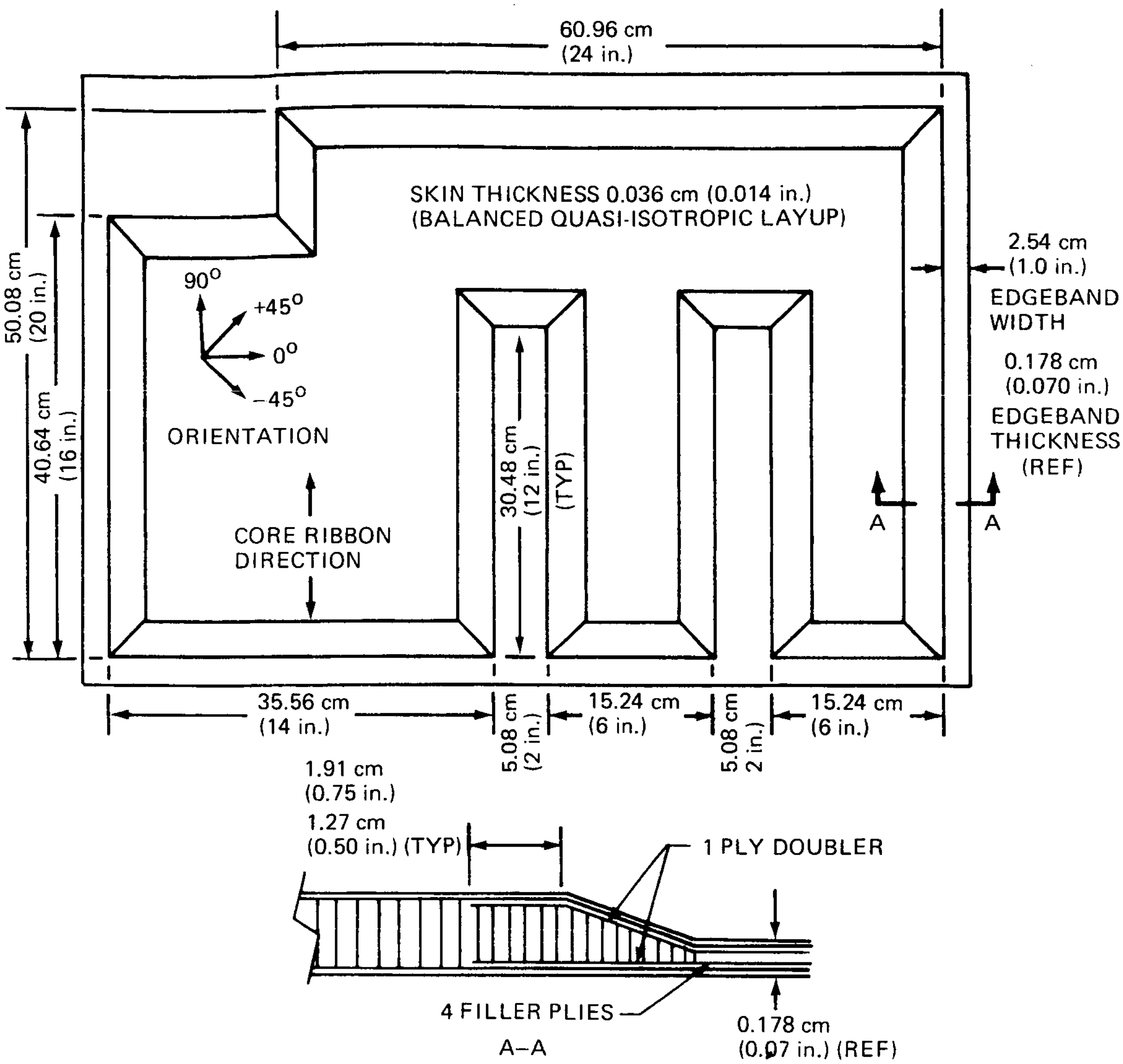
Material selection consisted of analysis and comparison of the above tests and included additional factors such as:

- Available industry data base
- Demonstrated resin durability in different environments
- Supplier production experience
- Supplier production capacity and control
- Supplier ability to provide all material forms
- Supplier cooperation for process audit

This Boeing-funded material evaluation resulted in the selection of the Narmco 5208 resin system. The 5208 system was selected because it best satisfied a majority of the selection considerations.

4.2 ANCILLARY TEST PROGRAM

An ancillary test plan has been established for evaluating the materials and processes to be used in this advanced composite design. These ancillary tests, encompassing all testing except ground and flight tests of the full-scale component, include coupon, element, and subcomponent-sized specimens. This test program provides the data for: establishing material design values including the environmental effects, material fatigue characteristics, specific design detail strength and fatigue performance; evaluating design concepts; and verifying final design details.



Note:

- Make from fabric and vendor preplied materials only.
- Doublers and fillers to be of the same material as panel skins.
- Nomex honeycomb core: BMS 8-124, type IV, grade 3.0, 1.27 cm (0.50 inches) thick, core chamfer: 20° ± 5°.
- Adhesive: 3M AF-143 (0.05 lb/ft^2)
- Pin hole filler and surfacer as required only to be applied to out skin of panel (tool side)
- Do not prime or paint

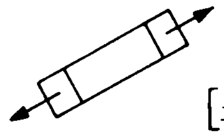
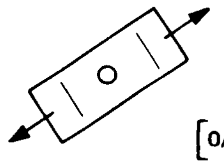
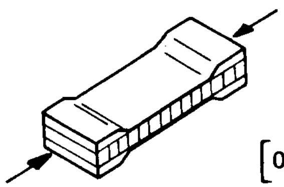
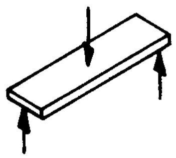
Figure 4-1 Manufacturing Producibility Panel

Subcomponent test specimens will serve several purposes. The test specimens will provide manufacturing experience with the resultant data provided to engineering design prior to final design release. Nondestructive inspection will be used during fabrication and testing to establish the presence and/or detectability of intentional and unintentional defects or structural damage. Intentionally damaged specimens will be repaired and their strength checked to evaluate repair techniques. Some damaged panels will be used for conductivity and lightning-strike protection system testing to minimize test costs.

With the exception of ground and flight tests of full-size components, the ancillary test plan defines all design development tests required to establish a basis for certification of advanced composites structures usage on the Boeing 727 aircraft elevator. These tests are an essential part of a structural integrity plan encompassing material qualification, specifications, design allowables, design, fabrication, testing, and certification.

Basic objectives of the ancillary test program are to support the design drawings releases and FAA certification. The test program philosophy is that sufficient "point design" tests will be conducted to obtain the data necessary to evaluate the typical design details of the elevator. Actual test values from the notched coupon and element (joint) testing will be used with appropriate corrections for basic properties to establish the material and joint design values. Subcomponent testing will verify major detail designs and margins of safety for the actual component detail.

Evaluations of the environmental effects on the material are included in the ancillary test program. The test plan for assessing the effect of environmental exposure on the static strength and durability of four selected graphite-epoxy specimens is shown on Figure 4-2. These specimen types were selected because environmental exposure effects are more readily identified for a matrix-critical part. Four different serverities of

Specimen configuration (7 mil fabric)	Size, centimeters (inches)	Exposure conditions	Exposure time (months and hours) 0 / 0	12 / 8760	24 / 17520	36 / 26280	Type OT test after exposure (test at room temperature)
 $[\pm 45]_{12}$	30.48x2.54 (12x1)	I	5	5	5	5	Static tension
		II		5	5	5	
		III		5	5	5	
		IV		5	5	5	
 1 $[0/90/\pm 45]_{3S}$	30.48x5.08 (12x2)	I	5	6	6	6	Fatigue test to failure R=10
		II		6	6	6	
		III		6	6	6	
		IV		6	6	6	
 FACES $[0/90/\pm 45]$	30.48x2.54 (12x1)	I	5	5	5	5	Static compression
		II		5	5	5	
		III		5	5	5	
		IV		5	5	5	
		IV 2	5	5	5	5	
 $[0/90]_{12}$	1.52x0.635 (0.6x0.25)	I	5	5	5	5	Static interlaminar shear test
		II		5	5	5	
		III		5	5	5	
		IV		5	5	5	

Exposure conditions

I Laboratory shelf exposure

II Outdoor rack exposure strained during exposure

III Flight exposure on airplane racks, strained during exposure

IV Webber chamber temperature, humidity and pressure cycling, strained during exposure

1 Three of each series of six specimens will be initially fatigue cycled to equivalent flight cycles corresponding to scheduled calendar time of exposure

2 One side painted (all other honeycomb specimens unpainted) (No ultra violet exposure of unpainted specimens)

Figure 4-2 Environmental Assessment Test Plan exposure will be used. Specimens will be exposed from zero to 36 months with some parts removed for test at the intervals noted. Results from these tests will be compared with data from the mechanical properties and material properties.

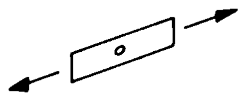
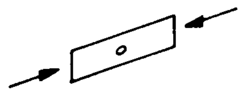
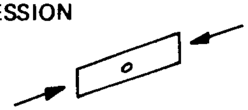
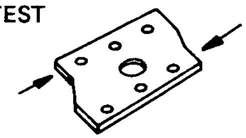
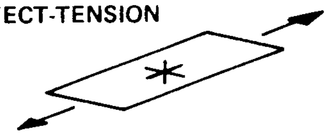
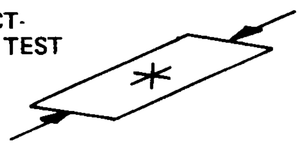
The material mechanical properties test plan is shown in Figure 4-3. Data from these tests will support establishment of design values for the selected material system to be used for certification.

Figure 4-4 shows the test plan for establishing structural element design values for various design details. These tests include both static strength and fatigue specimens. A number of the fatigue specimens will be residual-strength tested.

The subcomponent test plan is shown in Figure 4-5. These test results will be used to verify the design and durability of specific subcomponents of the elevator prior to fabrication of the first elevator unit.

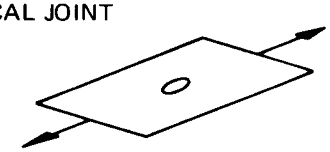
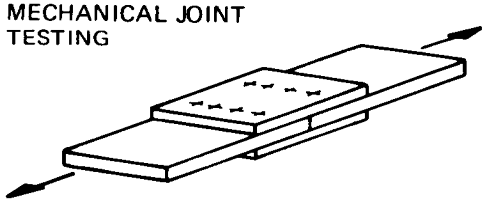
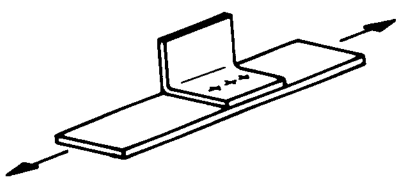
Figure 4-6 shows the plan for a test of the outboard section of the elevator. The test will include bending and torsion tests, hinge backup tests, and panel pressure loads tests.

Figure 4-7 shows the plan for verification testing of specimens cut from the production tooling tryout hardware. These tests will be undertaken to verify that the mechanical properties and strength of the production run parts are at least as good as the design values obtained from the tests used to provide data for establishing material and structural element properties.

Specimen	Fabric layup	Size, centimeters (inches)	Test condition [1]	Number of specimens RT	-65°F	+160°F	Data	Purpose	Remarks
TENSION TEST 	±45	38.10x3.81 (15x1.5)	Wet Dry	3 9	3 3	3 3	Load/strain	Effect of stress concentration	Parameters: edge margin hole size layup
	0/90/±45	38.10x3.81 (15x1.5)	Wet Dry	3 9	3 3	3 3			
COMPRESSION TEST 	±45	38.10x3.81 (15x1.5)	Wet Dry	3 9	3 3	3 3			
	0/90/±45	38.10x3.81 (15x1.5)	Wet Dry	3 9	3 3	3 3			
DEFECT COMPRESSION TEST 	±45	38.10x3.81 (15x1.5)	Wet Dry	3 9	– –	– –		Residual strength	
	0/90/±45	38.10x3.81 (15x1.5)	Wet Dry	3 9	– –	– –			
INPLANE SHEAR TEST 	±45	15.24x7.62 (6x3)	Wet Dry	3 9	3 3	3 3	Load/strain	Effect of stress concentration	
	0/90/±45	15.24x7.62 (6x3)	Wet Dry	6 9	6 6	6 6			
IMPACT DEFECT-TENSION TEST 	±45	38.10x3.81 (15x1.5)	Wet Dry	3 12	– –	– –	Load/strain	Residual strength	Parameters: defect size layup
	0/90/±45	38.10x3.81 (15x1.5)	Wet Dry	3 12	– –	– –			
IMPACT DEFECT-COMPRESSION TEST 	±45	38.10x3.81 (15x1.5)	Wet Dry	3 12	– –	– –			
	0/90/±45	38.10x3.81 (15x1.5)	Wet Dry	3 12	– –	– –			

[1] Wet condition denotes 1.1% moisture content achieved by conditioning in a 100% relative humidity chamber at 160°F

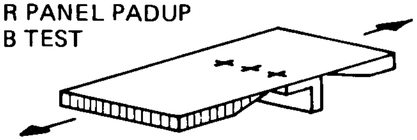
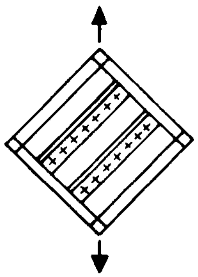
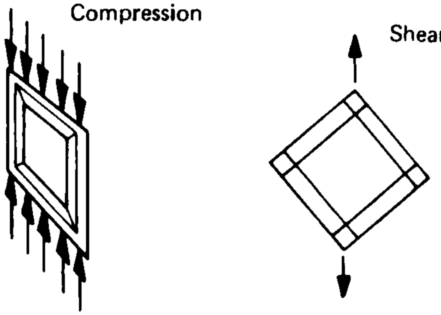
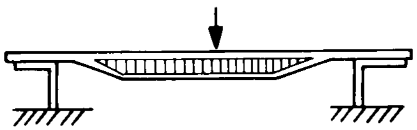
Figure 4-3 Mechanical Properties Test Plan

Specimen	Fabric layup	Size, centimeters (inches)	Condition [1]	Number of specimens: Static RT	Static −65 °F	Static +160 °F	Fatigue R=10: RT	Fatigue −65 °F	Fatigue +160 °F	Data	Purpose	Remarks
MECHANICAL JOINT TESTING 	0/90/$\pm$45	38.1x3.81 (15x1.5)	Dry	9	–	–	9	3	3	Life and failure load and mode	No load transfer strength and fatigue life	Parameters: Edge margin Hole size
			Wet	3	–	–	3	3	3			
MECHANICAL JOINT TESTING 	0/90/$\pm$45	Varies	Dry	33	3	3	33	3	3	Life and failure load and mode	100% load transfer joint strength	Parameters: Edge margin Fastener diameter Thickness Defects
			Wet	15	3	3	15	3	3			
			Dry	6	–	–	6	–	–			
			Wet	6	–	–	6	–	–			
MECHANICAL JOINT TESTING 	0/90/$\pm$45	38.1x2.54 (15x1)	Dry CSK	6	–	–	6	–	–	Life and failure load and mode	Effect of locally induced load transfer	Parameters: Thickness Defects
			Dry nonCSK	3	–	–	3	–	–			
			Dry CSK [2]	3	–	–	3	–	–			
			Dry [2] nonCSK	3	–	–	3	–	–			

[1] Wet condition denotes 1.1% moisture content achieved by conditioning in a 100% relative humidity chamber at 160°F

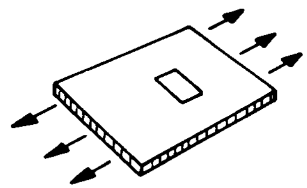
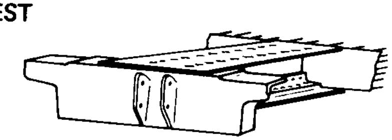
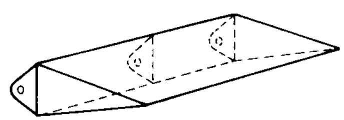
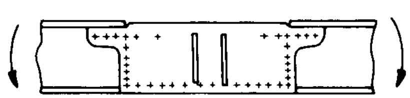
[2] t_1/t_2 and 1.0 defect

Figure 4-4 Structural Elements Test Plan

Specimen	Layup	Size, centimeters (inches)	Condition [1]	Number of specimens		Remarks
				Static	Fatigue	
COVER PANEL PADUP AT RIB TEST 	90/±45 2-ply faces honeycomb	6.35x63.5 (2.5x25)	RT, D RT, W	6 3	R=10 3 3	Design verification
SPAR SHEAR WEB AND STIFFENERS TEST 	±45	58.8x58.8 (20x20)	RT, D	3	–	Design verification
HONEYCOMB PANEL STABILITY TEST 	90/±45 2-ply faces honeycomb	55.88x55.88 (22x22)	RT, D RT, W RT, D damaged	3 3 3	– – –	Design verification
		55.88x55.88 (22x22)	RT, D RT, W RT, D damaged	3 3 3*	– – –	*Three panels will be used for lightning strike testing prior to static testing
PANEL EDGE SHEAR AND BENDING TEST 	90/±45 2-ply faces honeycomb	25.4x5.08 (10x2)	RT, D +load −load	3 3	R=0 3 3	Design verification

[1] Wet condition denotes 1.1% moisture content achieved by conditioning in a 100% relative humidity chamber at 160°F

Figure 4-5 Elevator Subcomponent Test Plan

Specimen	Layup	Size, centimeters (inches)	Condition [1]	Number of specimens		Remarks
				Static	Fatigue	
REPAIR STRENGTH TEST 	90/±45 2-ply faces honeycomb	58.8x58.8 (20x20)	RT, D −65, D +160, D RT, W −65, W +160, W	2 2 2 2 2 2	2 2 2 2 2 2	Residual strength after repair
ACTUATOR RIB VERIFICATION TEST 	Per drawing	58.8x20.32 (20x8)	RT, D +160, W	1 1	R=−1.0 1 1	Design verification
ELEVATOR BOX SONIC FATIGUE TEST 	Per drawing	167.64x 71.12 (66x28)	RT, D	—	1	Design verification
FRONT SPAR/ACTUATOR FTG SPLICE TEST 	Per drawing	91.44x20.32 (36x8)	RT, D +160, W	1 1	R=0 R=10 1 1	Design verification

[1] Wet condition denotes 1.1% moisture content achieved by conditioning in a 100% relative humidity chamber at 160°F

Figure 4-5 Elevator Subcomponent Test Plan (Cont)

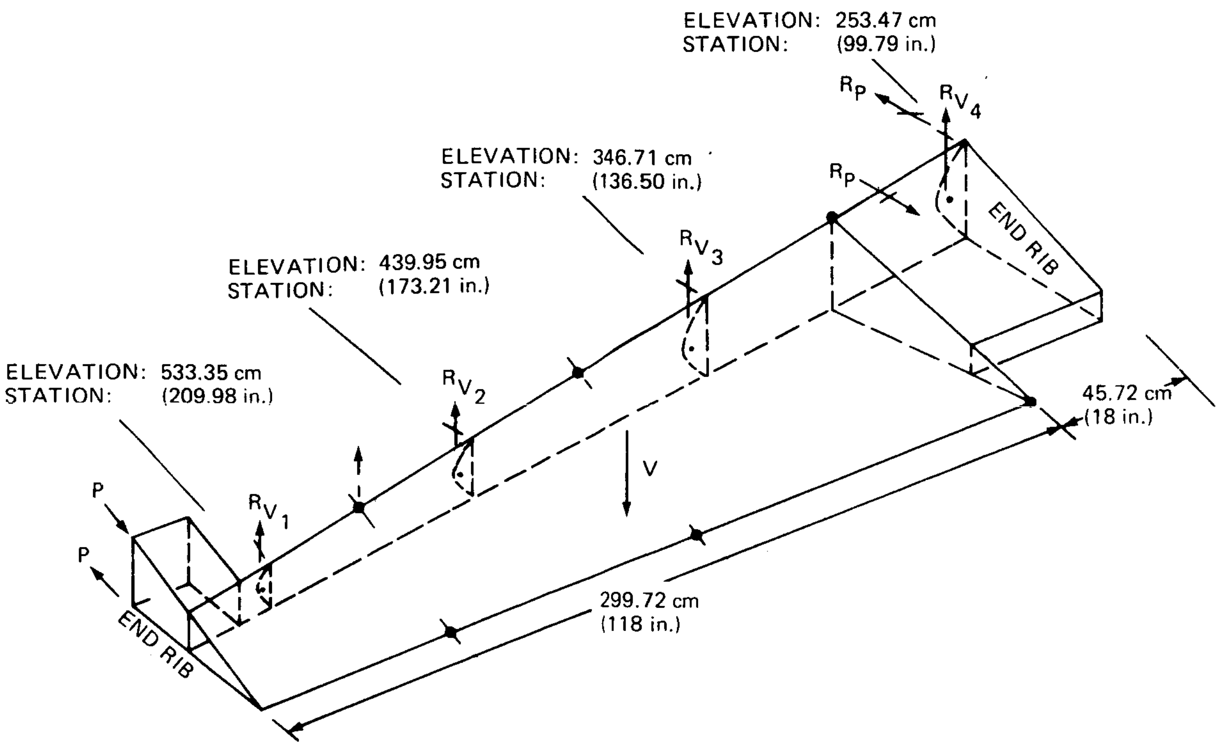


Figure 4-6 Test Section of Outboard Section of the Elevator

4.3 FULL-SCALE GROUND TEST

The full-scale ground test squence will include limit load, design life goal fatigue testing, design ultimate load test, damage tolerance (fail-safe) tests, followed by a test to destruction.

Testing will be conducted on the first production left hand unit. The test setup will include the capability to apply lift pressures to the elevator panels and induced elevator hinge loads from the stabilizer due to the stabilizer deflected shape at the critical design load.

Fatigue test loads will be the same as the most critical model 727 airplane flight spectrum.

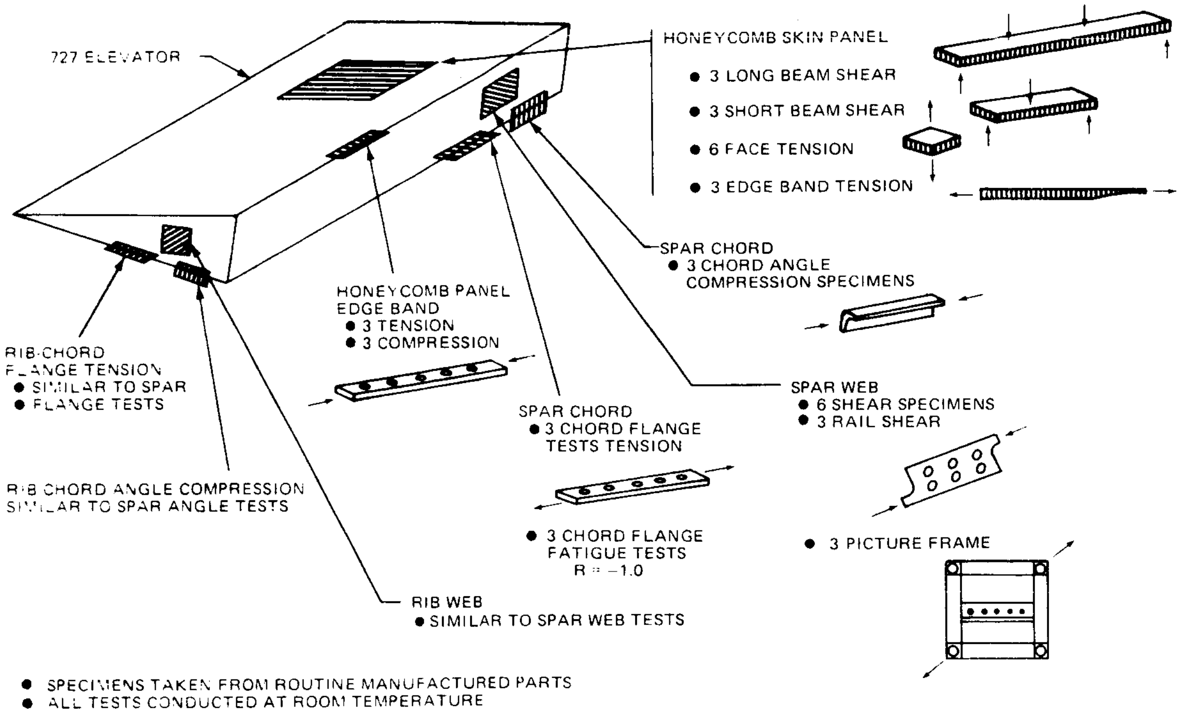


Figure 4-7 Testing of Production Verification Hardware

4.4 FLIGHT TEST AND FAA CERTIFICATION

4.4.1 Flight Test

The flight test program includes a ground vibration test of the elevator installed on the flight test airplane as well as inflight stability and control, and flutter and vibration evaluations.

Flight testing will be conducted with the second left hand and first right hand production articles installed on the flight test airplane.

Ground vibration tests will identify resonant frequencies and full-mode shape description will be obtained for modes that may be substantially different than those of the production 727 airplane.

Flight substantiation tests will be conducted according to FAA regulations to demonstrate the stability and control characteristics, flutter margins, and electromagnetic compatibility of the advanced composite elevator.

4.4.2 FAA Certification

Boeing's approach to support incorporation of advanced composite materials (ACM) into production airplanes is to develop capability for producing a light weight, cost effective article that meets Federal Aviation Regulations for certification. Certification is basically accomplished by analysis with verification of analysis and strength margins by test. A detailed FAA certification plan is currently being finalized.

The FAA certification plan will follow established procedures for current technology conventional material designs, together with more recent ACM certification guidelines. The procedure will include:

- Configuration definition
- Establishment of design criteria
- Materials and process specifications
- Analysis methods approach

- Test approach
  - Test criteria (design goals and environmental considerations)
  - Ancillary tests (basic structural element properties
  - Full scale ground test (limit load, fatigue ultimate load, fail-safe load, destruction)
  - Flight test
- Analysis and test documentation

The configuration definition will evaluate structural arrangement concepts and joining techniques. Compatibility with adjoining structure(s), inspection and maintenance provisions, and environmental protection features will be established.

Design criteria will define basic ground rules concerning airplane handling characteristics and performance, as well as actual structural design principles.

The material and process specifications will conform to the Federal Aviation Regulations requirements.

An analysis approach description will outline methods used to obtain margins of safety. It is required that analytical methods be proven by experience and/or test to be reliable and applicable to the particular structure being evaluated.

The test approach description will outline the logic of basic coupon and elements testing to subcomponent testing and finally the full scale major ground and flight testing.

Analysis and test documentation will be submitted to the Federal Aviation Administration in support of certification requirements.

SECTION 5

OPERATIONS DEVELOPMENT

This section discusses the results of precontract, Boeing funded, feasibility hardware trade studies, and manufacturing and quality assurance developments.

5.1 PRODUCIBILITY--TRADE STUDIES

A comparative cost study was conducted to evaluate the four elevator configuration concepts: honeycomb sandwich, multirib, multirib/bead stiffened panel, and multirib/ blade stiffened panel. This study is summarized in Table 3-1, Section 3.3. The following describes the results of other feasibility and producibility trade studies.

5.1.1 Rib Design

Two different rib designs were studied for producibility and cost (Figure 5-1). Honeycomb sandwich and corrugated laminate ribs were fabricated. Male tools (Figure 5-2) were used for each design and both feasibility parts were fabricated using 3K-70-P woven prepreg.

A time study showed that the corrugated rib took 2 1/2 times more man-hours to produce than the honeycomb sandwich. Also, the corrugated rib contained tool-side bridged areas in the female portion of the sine wave. These areas would require repair and rework in production. The defect occurred even though a rubber pressure pad was used to force the layup against the tool.

5.1.2 Elevator Section Feasibility Hardware

A full-scale 49-inch-long section of the elevator (Figure 5-3) was fabricated to establish the producibility and inspectibility of the elevator design and to highlight potential problem areas that required further evaluation. The elevator section included upper and lower graphite/epoxy sandwich skin

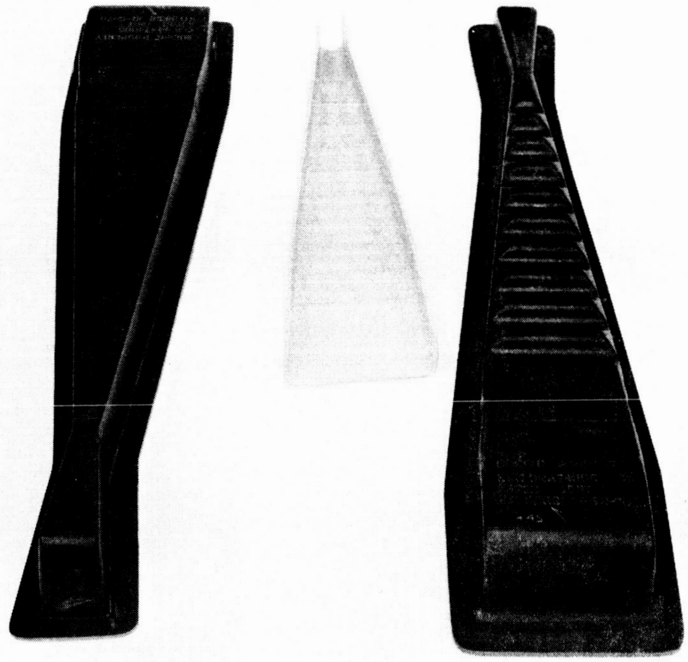


Figure 5-1 Rib Configurations

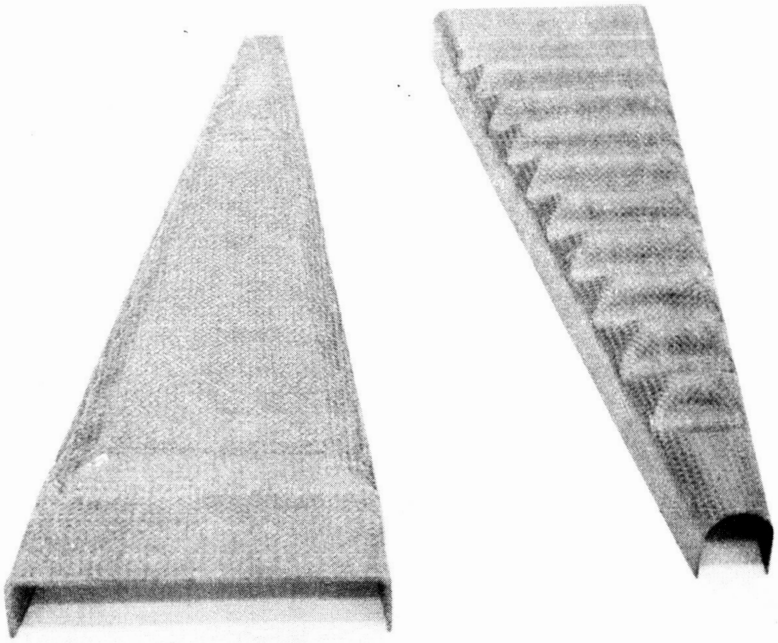


Figure 5-2 Rib Tools

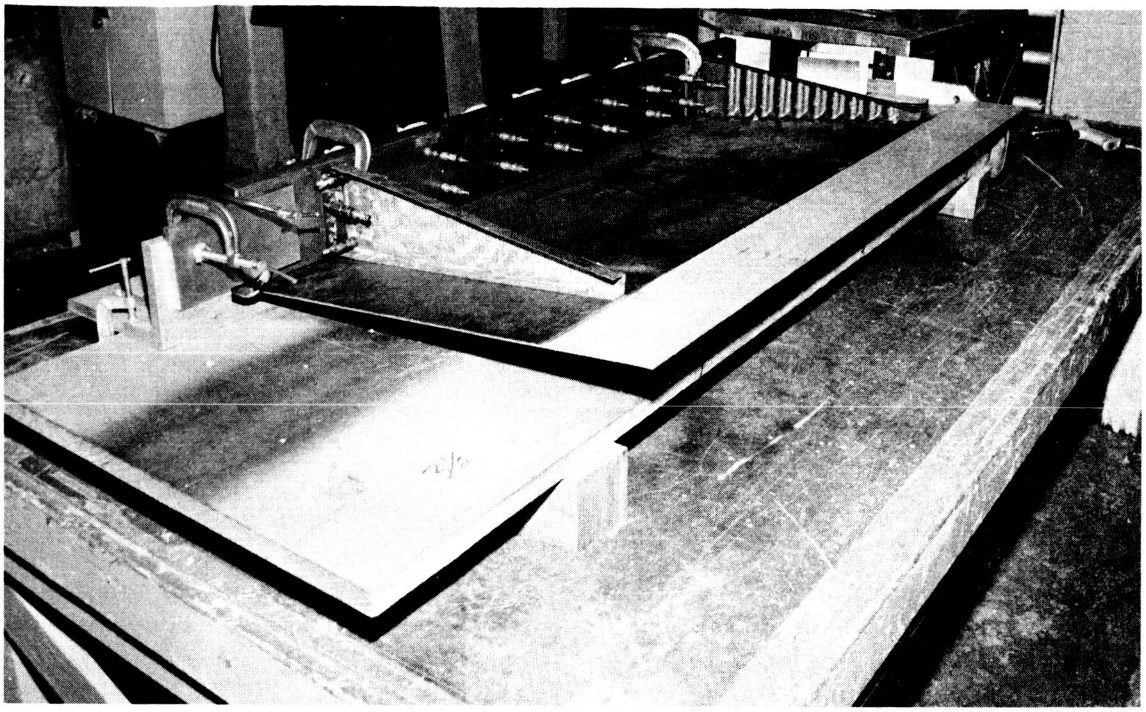


Figure 5-3 Elevator Section Assembly

epoxy laminate (see Section 5.1.1). Woven 3K-70-P fabric with a no-bleed, control flow epoxy resin system was used to fabricate all the composite details.

The skin panels were made on a thin-wall steel mold, machined to the exterior surface, and a female steel mold was used for the front spar. Both rib configurations were fabricated on male fiberglass/epoxy tools. Simple aluminum tooling was used for assembly.

All the composite details were made by production personnel experienced in structural fiberglass fabrication. Assembly also was accomplished by production personnel using titanium hi-lok and hollow rivet fasteners. After assembly and finishing, the elevator segment was structurally tested (see Section 3).

Fabrication of the elevator section demonstrated the producibility of the elevator design. It also established the following:

- Tooling approach was determined and the acceptability of the resulting tolerances.

- Cost-effectiveness of a no-bleed resin system and woven fabrics or broadgoods, such as preplied tape also was determined. Studies indicated that a no-bleed resin system would result in a 15-percent cost saving compared to a resin system that required surface bleeding. A cost savings of approximately $4.00 per square foot would be achieved by using woven fabrics or two-ply preplied broadgoods instead of 12-inch-wide tape. This saving includes the price premium for fabrics or preplied tape.

- Special training will not be required for production personnel experienced in structural fiberglass manufacturing. The core preparation, laminating, layup, bagging, cure, assembly, and finishing fiberglass experience is directly transferable to the composite elevator.

- Planning procedure--This will be the baseline for computerized "online" planning.

- Receiving, inprocess and nondestructive inspection procedures--Structural fiberglass receiving and inprocess procedures, with the exception of critical ply "buyoff" were used during the segment manufacture. Verification of the component quality was accomplished using C scan, ultransonic inspection. A procedure is being implemented to ensure traceability of graphite components.

During the assembly and finishing operation of the elevator segment, several potential production problems were identified. These problems included the countersinking of the graphite skin panels, the installation of a new titanium hollow rivet along the trailing edge, maintaining the 0.060-inch maximum trailing edge bondline, and the poor surface finish of the sandwich panels made from the 3K-70-P woven fabric.

To eliminate the countersinking problem, a special sequencing with a dual countersinking operation was instituted. The installation of the hollow titanium rivets, requiring special handling and methods, correct a cracking problem. An IR&D effort has been initiated to develop an improved titanium rivet fastener and installation procedure.

Hardware is currently being fabricated to establish tooling and layup sequence for obtaining the required bondline thickness. This will be described in the next quarterly report.

The woven fabric graphite skin panels required an excessive amount of surfacing compound and finishing labor to achieve an acceptable painted and sealed surface. The following section will describe material form, configuration, and finishing trade studies that were conducted to overcome this problem.

5.1.3 Skin Panel Material Form

Honeycomb sandwich skin panels (Figure 5-4 and Figure 5-5) were fabricated to determine the producibility and cost impact of various graphite material forms. Four-foot sections of elevator skin panels were made using equivalent amounts of the following material forms as skins:

- 3K-70-P woven fabric
- Two-ply, 0.0035-inch, preplied tape
- Four-ply, 0.0035-inch, preplied tape
- 12-inch-wide, 0.0052-inch unidirectional tape

Woven fabric was the most cost-effective material form studied. Even though not part of this study, the open-weave characteristics of the 3K-70-P fabric will require more finishing time than the unidirectional or preplied tape. As illustrated in Figure 5-6, significant surface filling is needed to achieve an acceptable paint finish and to eliminate surface porosity. The result of a finishing study will be described in the next section.

Figure 5-4 Layup of Fabric Skin Panel

Figure 5-5 Layup of Preplied and Tape Skin Panel

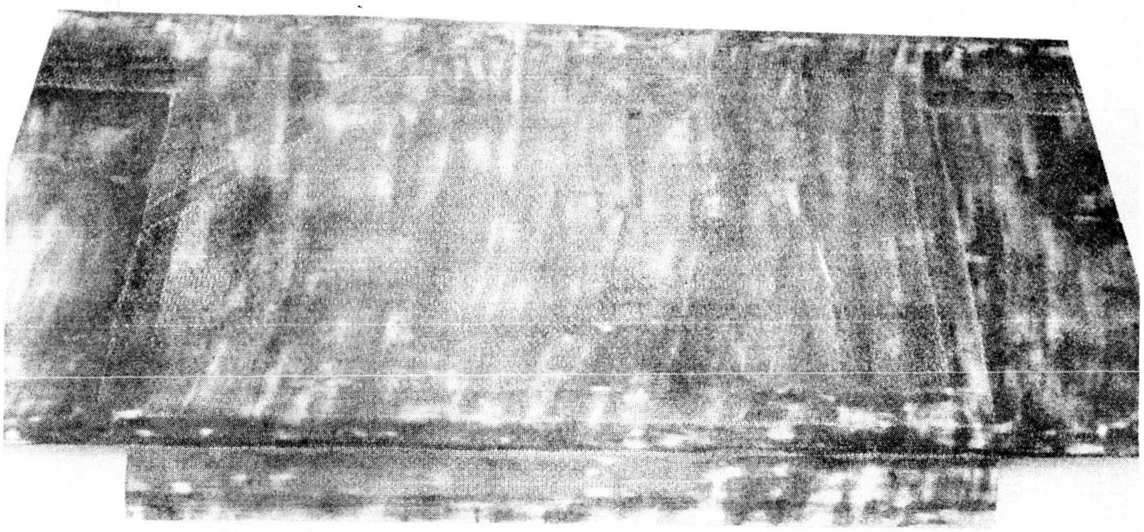


Figure 5-6 Skin Panel After Surface Finishing

The two-ply, preplied labor was 25 percent greater than the woven fabric. One of the three components fabricated from two-ply, preplied tape had collapsed core in the trailing-edge area, indicating a potential problem when preplied tape is used over honeycomb core. This, if not corrected, would cause a prohibitive high rejection rate.

Working with four-ply, preplied tape was time consuming. This is attributable to the difficulty experienced in forming the material over the honeycomb core and in the leading-edge contour. The four-ply, preplied fabrication labor was 10 percent greater than for the woven fabric. However, the four-ply, preplied component was not of acceptable quality.

The fabrication labor for the component fabricated from 12-inch unidirectional tape was 39 percent greater than for the woven fabric. The panels made from unidirectional tape also showed core-collapse tendencies.

The drilling characteristics of the panels were evaluated after fabrication. All the panels made with preplied or unidirectional tape experienced unacceptable breakout on the exit side of drilled holes. There were no problems in drilling the woven fabric panel.

5.1.4 Surface Finish Study

The surface finish of composite components involves the application of static conditioner, epoxy surfacer, primer, and the top coat. Panels fabricated from improved woven fabrics (minimum porosity 3K-70-P fabric) and unidirectional tapes were studied during the static conditioner and surface application finishing operations. The average time for application of static conditioner and surface was 2.9 times greater for woven fabric than tape. Table 5-1 illustrates the labor for producing panels from fabric, preplied tape, and unidirectional tape when the finishing time is included.

Table 5-1 Finishing Cost Study

MATERIAL FORM	RELATIVE COST	
	WITHOUT FINISHING	WITH FINISHING
WOVEN FABRIC	1.00	1.00
TWO-PLY, PREPLIED TAPE	1.25	1.21
FOUR-PLY, PREPLIED TAPE	1.10	1.05
TWELVE-INCH-WIDE, UNIDIRECTIONAL TAPE	1.39	1.35

5.1.5 Skin Panel Configuration

A 20- by 36-inch sandwich feasibility panel was made of the fabric construction (see Section 3.4.1) to evaluate the tape and fabric combination. The fabric on each side of the core should eliminate concern for warpage and minimize fiber breakout during drilling. Use of fabric fillers on edge bands offers reduced layup time, and the fabric doublers eliminate the core crush in the core chamfered areas.

The producibility panel met most of the manufacturing objectives. Surface finish was equivalent to the results achieved with an all-tape construction. There also was no panel warpage or core collapse. The fabrication time was slightly longer than for the all-fabric panel. The relative labor of the combination panel, including finishing, was 1.01 compared to 1.00 for the all-woven fabric panel and 1.35 for the all-tape panel.

Drilling and countersinking caused some fiber breakout on the tape entrance surface. However, this condition would be acceptable. There was no breakout on the fabric drill exit surface.

5.1.6 Rib Configuration

A study rib was fabricated to improve surface finish of the honeycomb design. As in the panel design, unidirectional tape was substituted for fabric on the tool side of the rib.

A producibility trade made during rib layup showed that a single ply of tape did not significantly increase the fabrication labor. The tool surface finish was improved and will require little or no conditioner or surface application.

Drilling tests showed a significant amount of fiber breakout. For this reason, it was decided to retain fabric on the tool-side surface. The new minimum porosity fabric weave has shown promise for reducing the finishing time.

SECTION 6

REFERENCES

1. "727 Structural Design Loads," Boeing Document D6-5863.

2. "727 Horizontal Tail Stress Analysis," Boeing Document D6-5873.

3. "Boeing Design Standards," Boeing Document D-5000.

4. "Advanced Composites Design Guide" Volume I, Third Edition.

5. "Requirements for Epoxy Resin Impregnated Graphite Fibers," Boeing Document XBMS 8-212.

6. "Manufacture of Autoclave Cured Graphite/Epoxy Structural Parts," Boeing Document XBAC 5562.

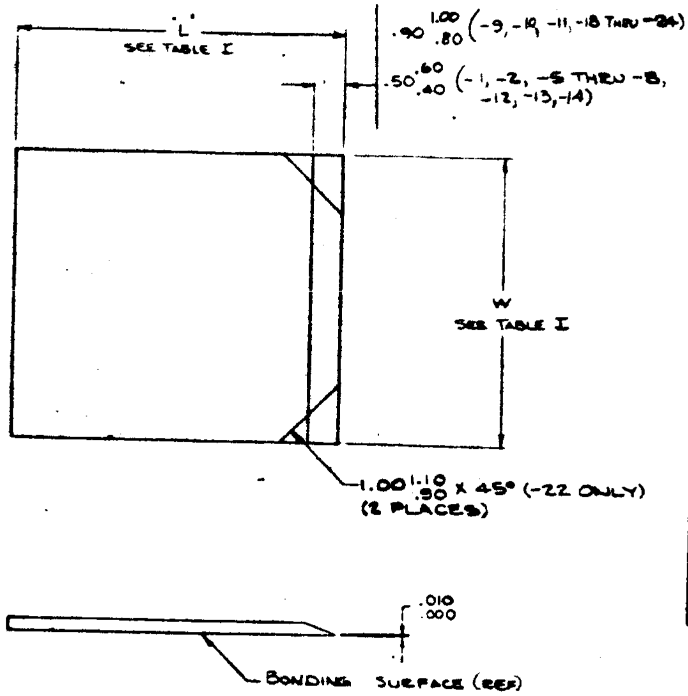
7. Hart-Smith, L. J., "Bolted Joints in Graphite/Epoxy Composites," NASA Report CR-144899, January 1977.

8. "Development of Engineering Data on the Mechanical and Physical Properties Advanced Composites Materials," Technical Report AFML-TR-74-266, February 1975.

Boeing Commercial
Airplane Company
Contract NAS1-14952

APPENDIX A

ENGINEERING DRAWINGS

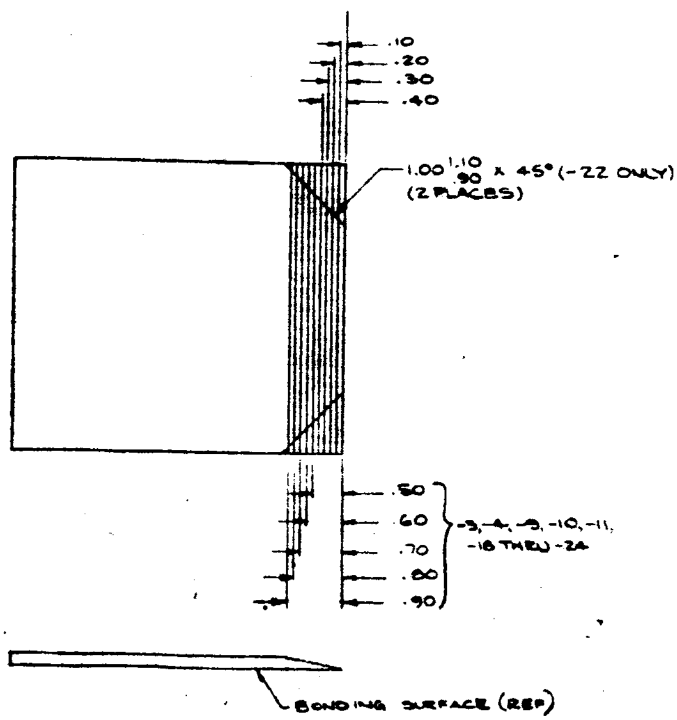


-1 THRU -14, -18 THRU -24

FOR OPTIONAL METHOD SEE BELOW

TABLE I

PART NO	W (INS)	L (INS)	t_c (INS) ± .005
-1	4.00	3.00	.050 (5 PLIES)
-2	4.80	3.00	.050 (5 PLIES)
-3	4.80	3.00	.100 (10 PLIES)
-4	6.40	3.00	.100 (10 PLIES)
-5 & -13	1.00	3.00	.050 (5 PLIES)
-6	3.50	8.75	.050 (5 PLIES)
-7	45.00	8.75	.050 (5 PLIES)
-8 & -14	1.50	3.00	.050 (5 PLIES)
-9	1.00	3.50	.100 (10 PLIES)
-10	2.00	3.50	.100 (10 PLIES)
-11	1.50	3.50	.100 (10 PLIES)
-12	4.00	3.00	.050 (5 PLIES)
-18	2.28	3.50	.100 (10 PLIES)
-19	3.80	3.50	
-20	5.32	3.50	
-21	2.50	3.50	
-22	23.50	3.00	
-23	16.00	3.65	
-24	12.50	6.00	.100 (10 PLIES)



FOLD-OUT #1

1. GLASS FABRIC REINFORCED PLASTIC PER BMS 8-79 CLASS III TYPE 1581 (.010 INS THICK PER CURED PLY) FABRICATE PER BAC 5470 (PEEL PLY REQD ON BONDING SURFACE.

2. GLASS FABRIC REINFORCED PLASTIC PER BMS 8-139 TYPE 181 (.010 INS THICK PER CURED PLY) FABRICATE PER BAC 5529 (PEEL PLY REQD ON BONDING SURFACE.

RELEASE		QTY REQD	PART OR IDENTIFYING NUMBER	NOMENCLATURE OR DESCRIPTION	ZONE	MATERIAL AND SPECIFICATION	HT-TR	FINISH	PT MK	REV LTR
		1	-24	GRIP DOUBLER		.100 x 6.00 x 12.50			M	A
		1	-23			.100 x 3.70 x 16.00				
		1	-22			.100 x 23.50 x 3.00				
		1	-21			.100 x 2.50 x 3.50				
		1	-20			.100 x 5.40 x 3.50				
		1	-19			.100 x 3.80 x 3.50				
		1	-18	GRIP DOUBLER		.100 x 2.30 x 3.50			M	A
		1	-14	GRIP DOUBLER		.050 x 1.50 x 3.00 2			M	A
		1	-13			.050 x 1.00 x 3.00 2				
		1	-12			.050 x 4.00 x 3.00 1				
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		1	-10			.100 x 2.00 x 3.50 1				
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		1	-8			.050 x 1.50 x 3.00 1				A
		1	-7			.050 x 8.75 x 43.00 1				
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		1	-5			.050 x 1.00 x 3.00 1				
		1	-4			.100 x 3.00 x 6.40 1				
		1	-3			.100 x 3.00 x 4.80 1				
		1	-2			.050 x 3.00 x 4.80 1				
		1	-1	GRIP DOUBLER		.050 x 3.00 x 4.00 1			M	

LIST OF MATERIAL

SYM	ZONE	REVISIONS
A		ADDED PARTS -8 THRU -24. TO PICTURE, TABLE 1 & ADDED 2 ADDED PEEL PLY REQMT. 5 PARTS REQD ... MATL ALLOWABLES PROGRAM. P NO PARTS MADE. ALL PARTS MUST COMPLY

ADVANCED COMPOSITES

DESIGN IMPROVEMENT

GRIP DOUBLER, FIBERGLASS 65C17700

NO PARTS COMPLETED - ALL PARTS MUST COMPLY

NEXT ASSY	USED ON	SECT NO	SERIAL NUMBER	PART NUMBER	RELEASE COLUMN INDICATOR	DRAWING SHEET NUMBER	REV LTR

APPLICATION

CHANGE NO: EWA

THE BOEING COMPANY
COMMERCIAL AIRPLANE DIVISION RENTON WASH.

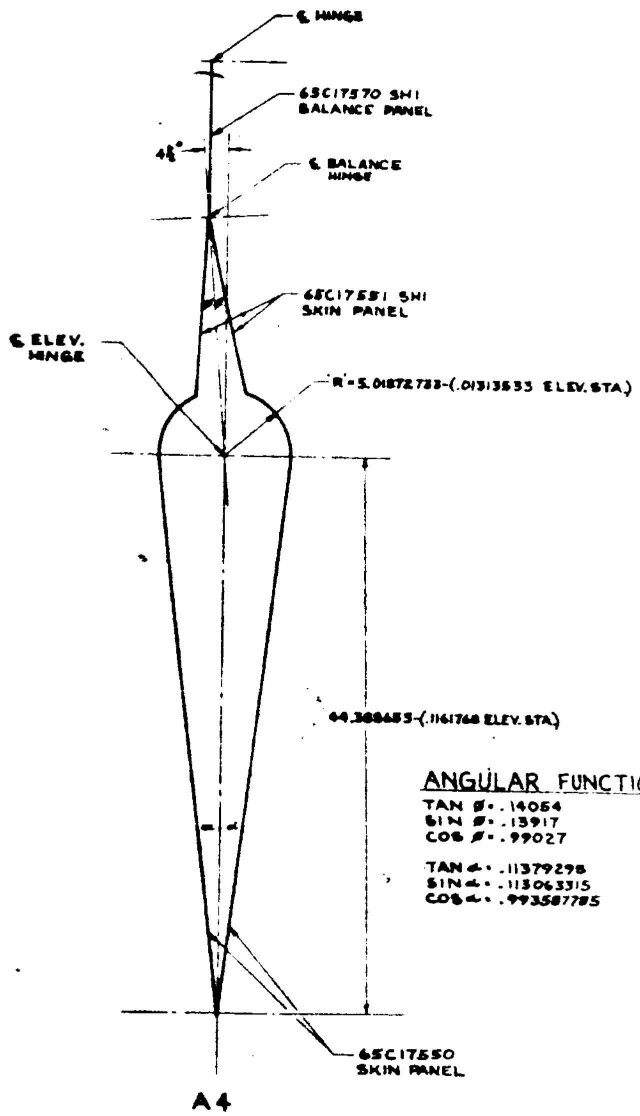
GRIP DOUBLER, FIBERGLASS - TEST SPECIMENS

DWG ORIG BY (GROUP): ADVANCED COMPOSITES

CODE IDENT NO 81205 | SIZE J | 65C17700

65C17700 | SH 1

FOLD-OUT #2



ANGULAR FUNCTIONS

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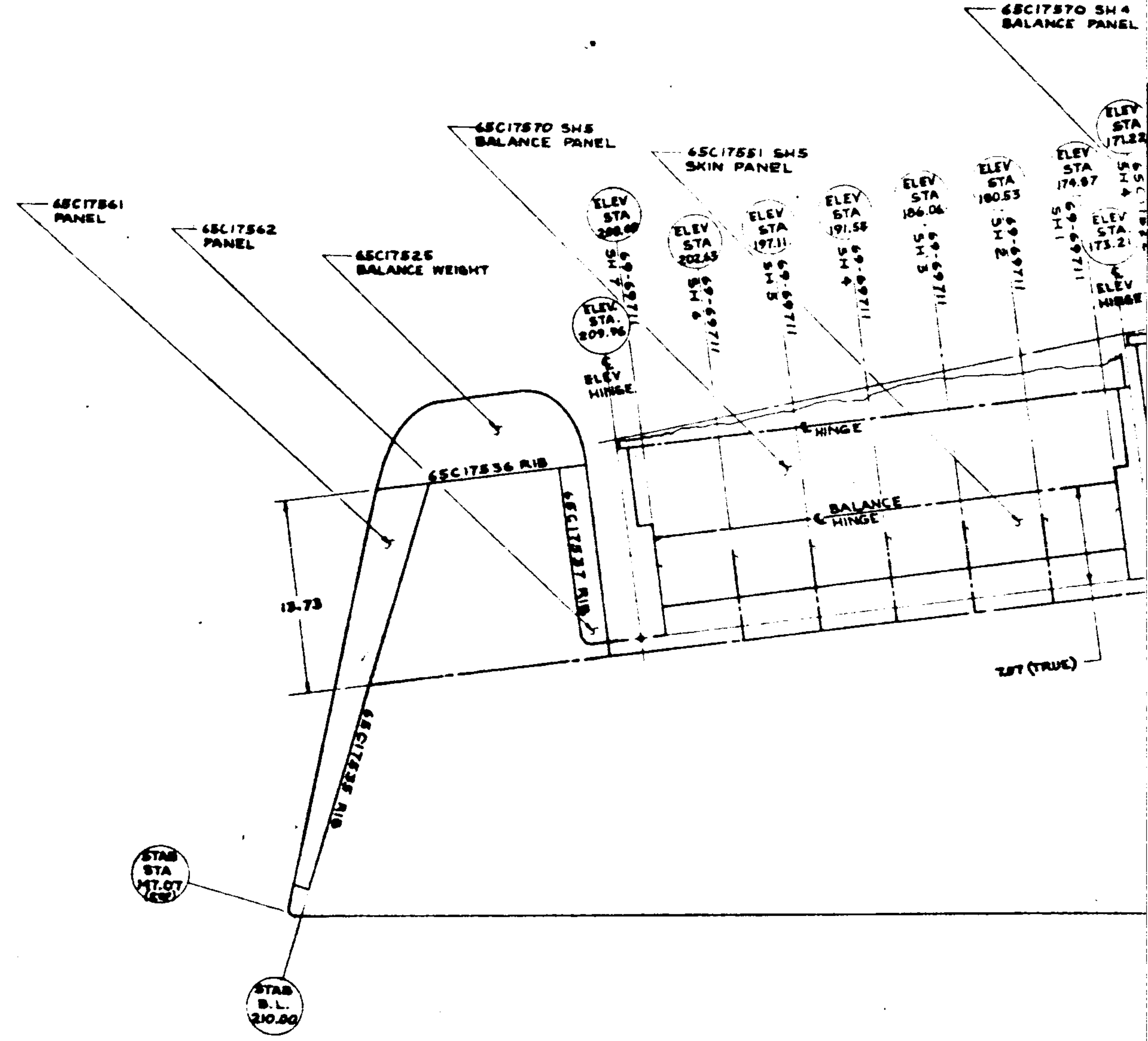
SIN Ø = .13917
COS Ø = .99027

TAN ∠ = .11379298
SIN ∠ = .113063315
COS ∠ = .993587785

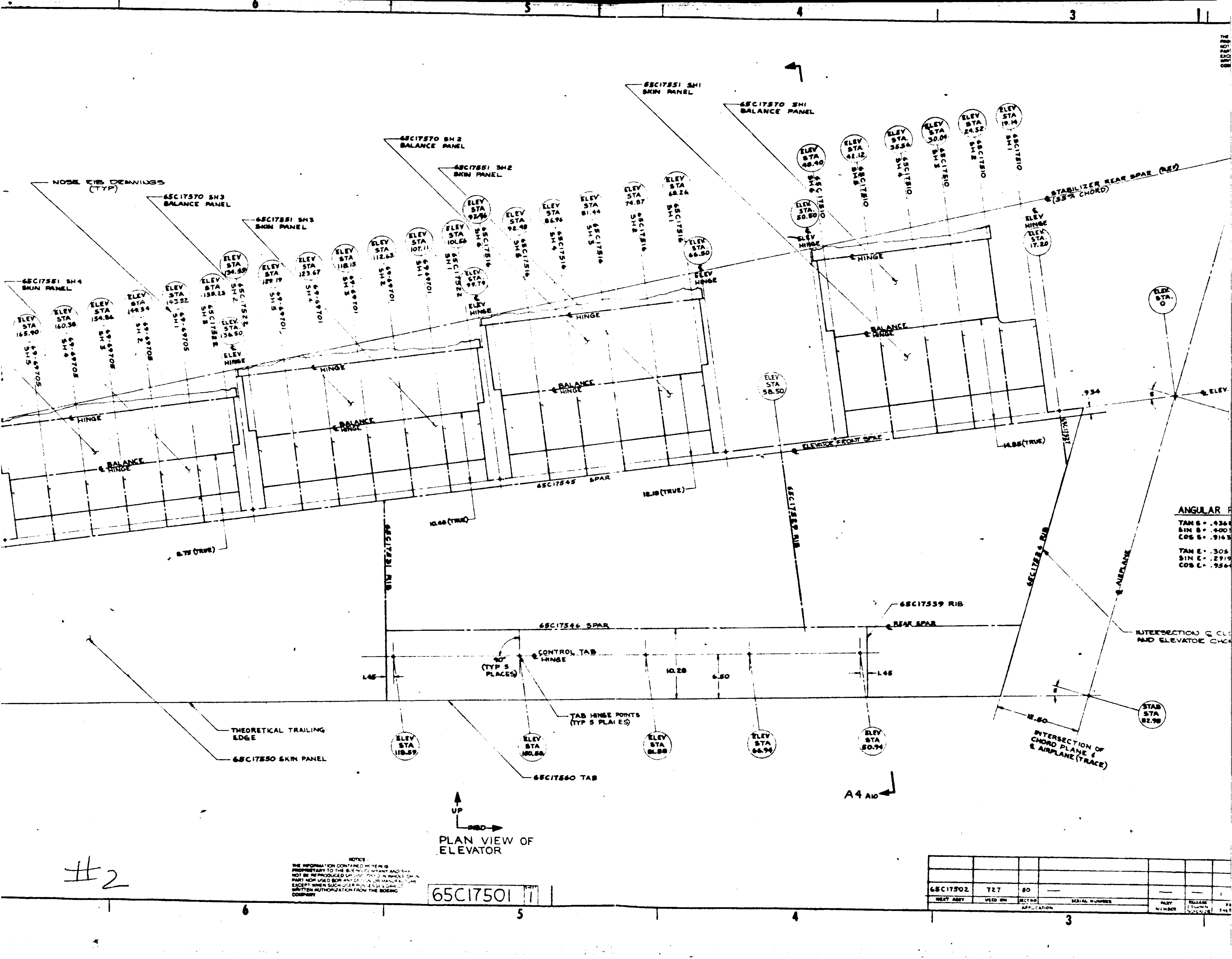


NOTICE
THE INFORMATION CONTAINED HEREIN IS PROPRIETARY TO THE BOEING COMPANY AND SHALL NOT BE REPRODUCED OR [illegible]
PART NOR USED [illegible]
EXCEPT WHEN SUCH USER [illegible]
WRITTEN AUTHORIZATION FROM THE BOEING COMPANY

65C17501 | 1

#1

11 10 9 8 7



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[PART] NOR USED FOR ANY DESIGN OR MANUFACTURE
[EXCE]PT WHEN SUCH USER POSSESSES DIRECT
[WRIT]TEN AUTHORIZATION FROM THE BOEING
[COM]PANY.

FASTENER SYMBOL CODE

INSTL STD. PER BAC 5004. FLUID TIGHT PER BAC 5047

BASIC CODE — ENCLOSED = FLUID TIGHT; OPEN = STANDARD

DIA DASH NO

MFD HEAD LOC — N = NEAR SIDE; F = FAR SIDE

XX | XX

DXC | XW

DIMPLE/CSK INFO — D = DIMPLE; 2 = NO. SH-DIMPLED; C = CSK IN STRUCTURE; 2 LINES: TOP = MFD HD, BOTTOM = DRIVEN HD

SPOT WELD OPT

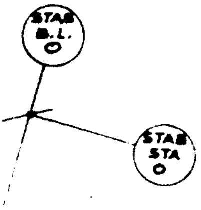
LENGTH DASH NO

NOTE: PROTRUDING HD RIVETS DRIVEN FLUSH
D/C INFO (2 LINES) APPLIES TO DRIVEN HD ONLY

HOLE LOCATION FOR 1/16 DIAMETER RIVET

HOLE LOCATION FOR 1/16 DIAMETER BOLT

REVISIONS				
SYM	ZONE	DESCRIPTION	DATE	APPROVAL



HINGE (75% CHORD)

STAB STA 34.88

C

UNCTIONS

.17421
.3745   ε = 23°35'   57.3917"
.4777

.2075
.1409   ε = 16°58'   21.3019"
.4454

B

[CL]OSURE RIB
[...]D PLANE

NOTE: CONTOUR PER MDD208
GEOMETRY ℓ NOSE CONTOUR OF ELEVATOR
IS THE SAME OR SIMILAR TO THAT SHOWN
ON DWG. 65-72790 SH 2 (REF).

MAJOR DRAWING No.S
65-72700 MAJOR DRAWING No. INDEX
65-72701 FINAL ASSY. MODEL 727
65-72780 HORIZONTAL TAIL INSTL.
65-72790 CENTERLINE DIAGRAM STABILIZER
64-8341 LOFT LINES HORIZONTAL TAIL
65C17502 STABILIZER ℓ ELEVATOR ASSY.
65C17503 ELEVATOR ASSY.
65C17504 ELEVATOR BALANCE ASSY.

#3

A

FORM, PUNCH, STRAIGHTEN & FIT METAL PARTS PER BAC 5300
BOLT & NUT INSTALLATION PER BAC 5009
MATERIAL SUBSTITUTION & EQUIVALENTS PER BAC 5005
SST MATERIALS SUBSTITUTIONS & MANUFACTURING PROCESSES PER D6-19736
PART MARKING PER BAC 5307
SEE BACD 2097 FOR SURFACE ROUGHNESS
FOR FINISH CODES SEE DOCUMENT D2-5000 & OR D6-5000

DIMENSIONING & TOLERANCING PER USAS Y14.5

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
ANGLES ± DECIMALS ±
RIVET & BOLT EDGE MARGINS ± .05
SHEET METAL CORNER RADII
INTERNAL .16 $\frac{.19}{.16}$
EXTERNAL .22 $\frac{.25}{.00}$
BEND RADII
± .01 ON .03 & .06
± .03 ON .09 & GREATER

SEE SHEET 1 OR PL FOR LIST OF MATERIAL USAGE AND NOTES

USED ON 727	DRAWN L. R. HELGESON	DATE 5-3-77	THE BOEING COMPANY, COMMERCIAL AIRPLANE DIVISION, RENTON, WASH
	CHECKED	6/16/77	CENTERLINE AND STRUCTURAL ARRANGEMENT DIAGRAM - ELEVATOR.
SECT NO 80	STRESS		
	ENGR ...ENDER		
CHG NO PIN 848000	GROUP		CODE IDENT NO 81205 — SIZE J — 65C17501
GROUP ORG ADVANCE COMPOSITE	PROJ		SCALE 1/4 — SH

DRAWING RECORDS CLERK

65C17501

ISSUE NO
WAS SH
REV SH
SH 1

A-3

D1-4

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—	BAC5470	[illegible] SPEC
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—	-130	PLATE
—	-129	PLATE
—	-128	
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1	-118	STRAP
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ZONE | MATERIAL AND SPECIFICATION | HT TR | FINISH | PT MK | REV LTR

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#1

65C17702 SH 1

13 12 11 10

C B A

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	65C17100-3							
	65C17100-13							
	65C17100-5	GRIP DOUBLER						
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—	-18							
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—	-13							
—	-12							
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RELEASE

1. INSTA…
2. FILL… HAVE… CORN… FEAT…

LIST OF MATERIAL

65C17702 SH 1

#2

DIA HI-LOKS IN .1895 $^{.1925}_{.1895}$ DIA HOLE

RAPHITE/EPOXY SPECIMENS SHOULD
TH SHARP CUT EDGES. SQUARE
SQUARE EDGES WITH NO TAPERS OR
EDGES

1 EPOXY PRE IMPREGNATED GRAPHITE FABRIC PER XBMS 8-212, TYPE I, CLASS 2, STYLE 3K-70-P FABRICATE PER XBAC 5562 EXCEPT TOLERANCE ON PLY ORIENTATION WILL BE ±3° & NO SPLICES ALLOWED.

2 PLY ORIENTATION CONVENTION FABRIC: 0° IS PARALLEL TO THE WARP DIRECTION

3 BOND GRIP DOUBLER TO GRAPHITE EPOXY PLATE WITH BMS 5-80 TYPE 2, GRADE 5, CLASS II (BMS 5-51 OPTIONAL) PER BAC5514-580 (PEEL PLY REQD ON BONDING SURFACE)

4 SANDBLAST THIS SURFACE OF GRIP DOUBLER LIGHTLY AS REQUIRED TO IMPROVE GRIP CAPABILITY

5 10 INCH-POUND ENERGY IMPACT

6 30 INCH-POUND ENERGY IMPACT

7 55 INCH-POUND ENERGY IMPACT

8 TFE FILM PER AMS 3652, .003 THICK

9 INSTALL ALL BACC30M( ) COLLARS WITH BACW10BX( )L WASHER UNDER COLLAR

10 INSTALL CENTERED AS SHOWN BETWEEN PLY P1 & P2

11 PART MARKING LOCATION FOR ASSY NO.

12 INSTALL CENTERED AS SHOWN BETWEEN PLY P7 & P8 OF -117

00 LIMITED - SEE L/M FOR USAGE

13 X-RAY INSPECT HOLE PER QC R&D REQUIREMENTS

DIMENSIONING & TOLERANCING PER USAS Y14.5
PART MARKING PER BAC 5307
SEE BACD 2097 FOR SURFACE ROUGHNESS
~~BORE, PUNCH, REAM, HEAT & FIT METAL PARTS PER BAC 5000~~
BOLT & NUT INSTALLATION PER BAC 5009
~~MATERIAL SUBSTITUTIONS & EQUIVALENTS PER BAC 5005~~
~~SEE MATERIALS SUBSTITUTIONS & MANUFACTURING PROCESSES SEE D6-10236~~
~~FOR FINISH CODES SEE DOCUMENT D6-5000 & D6-5000~~

FASTENER SYMBOL CODE

INSTL. STD. PER BAC 5004; FLUID TIGHT PER BAC 5047
BASIC CODE: ENCLOSED = FLUID TIGHT; OPEN = STANDARD
DIA DASH NO
MFD HEAD LOC: N = NEAR SIDE; F = FAR SIDE
DIMPLE/CSK INFO: D = DIMPLE; $ = NO. SH DIMPLED; C = CSK INSTRUCTURE; 3 LINES - TOP = MFD HD; BOTTOM = DRIVEN HD
SPOT WELD OPT
LENGTH DASH NO.
NOTE: PROTRUDING HD RIVETS DRIVEN FLUSH. B/C INFO (2 LINES) APPLIES TO DRIVEN HD ONLY

HOLE LOCATION FOR 3/16 DIAMETER RIVET
HOLE LOCATION FOR 3/16 DIAMETER BOLT
XTO = BACB30NA( ) ( ) = BACC30M( ) 9

SYM	ZONE	REVISIONS DESCRIPTION	DATE	APPROVAL

NEXT ASSY	USED ON	SEC NO	SERIAL NUMBER	PART NUMBER	RELEASE	DRAWING SHEET NUMBER	REV LTR

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES: ANGLES ± — DECIMALS ± —
RIVET & BOLT EDGE MARGINS ± .05
SHEET METAL CORNER RADII: INTERNAL 16 $^{19}_{16}$; EXTERNAL 22 $^{25}_{00}$
BEND RADII: ± .01 ON .03 & .06; ± .03 ON .09 & GREATER

CHANGE NO: EWA 1132 BT, EWA 1132 GT
DWG ORIG BY (GROUP): ADVANCED COMPOSITES

DRAWN — CHECKED — STRESS — ENGR — GROUP — PROJ

THE **BOEING** COMPANY
COMMERCIAL AIRPLANE DIVISION RENTON WASH

NASA TEST SPECIMENS-MATERIAL ALLOWABLES, ADVANCED COMP ELEVATOR

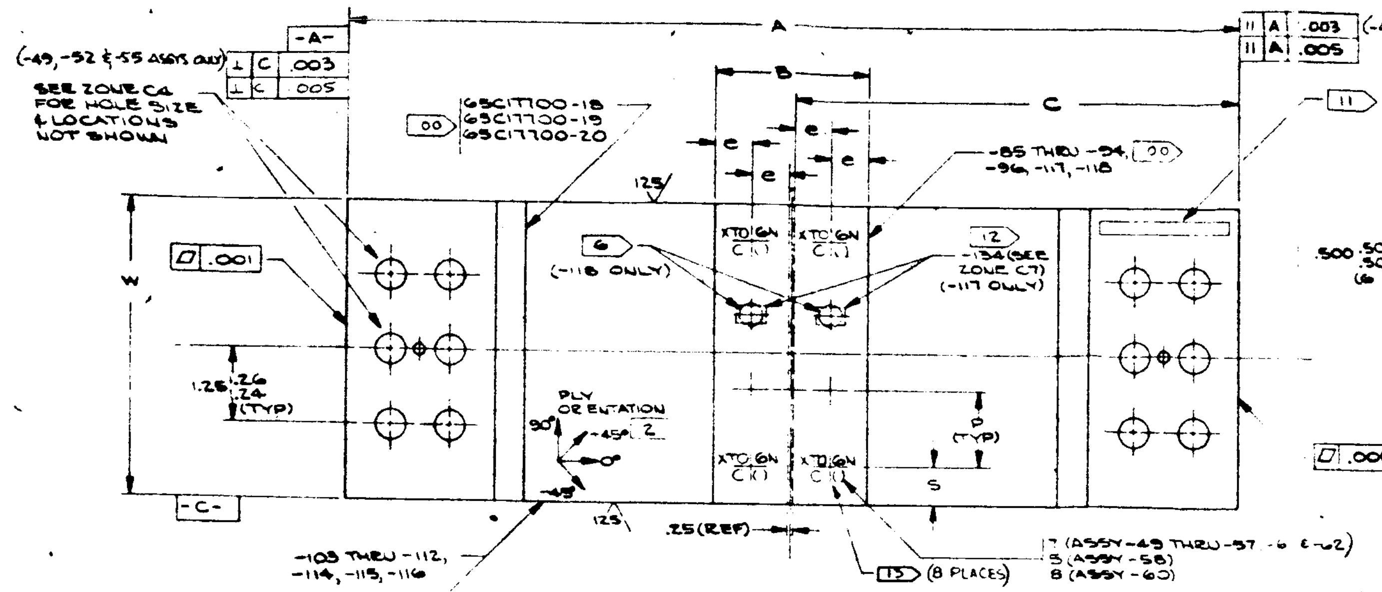
CODE IDENT NO 81205 | SIZE J | 65C17702

SCALE | SH

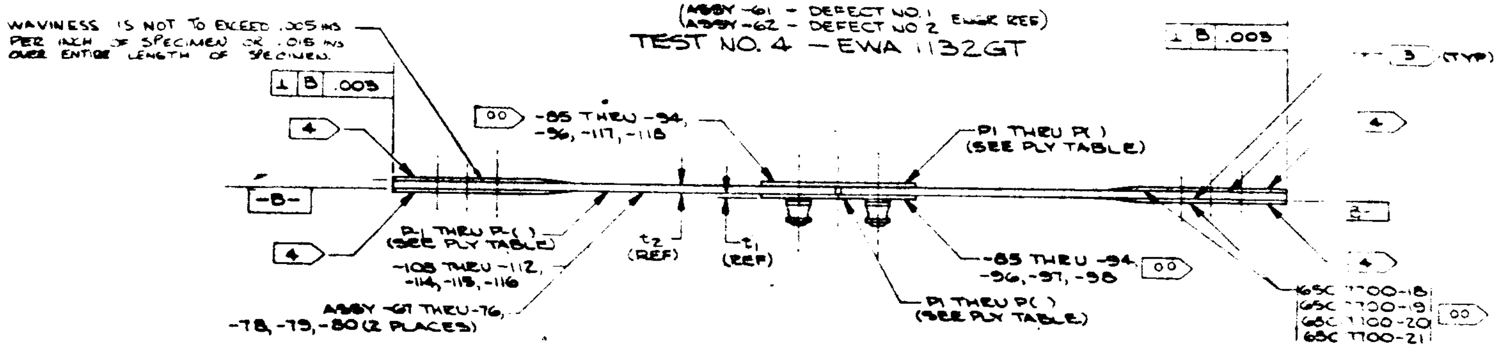
65C17702 | SH 1 | REV SYM | WAS A88

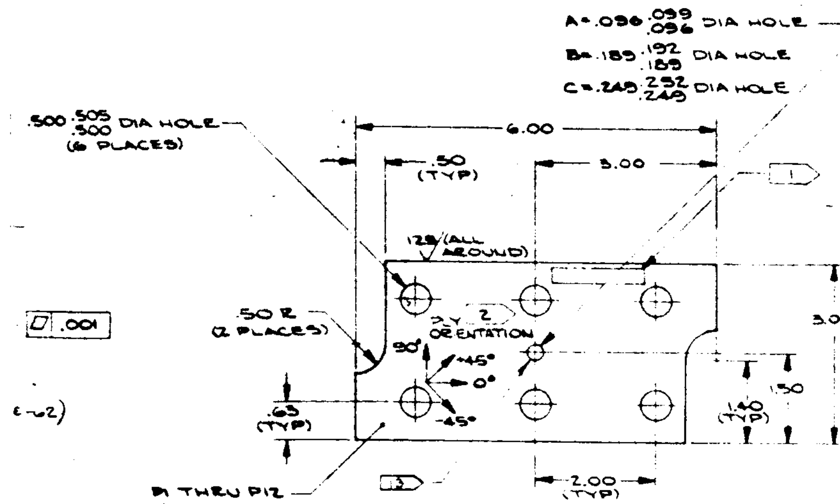
#3

A-4

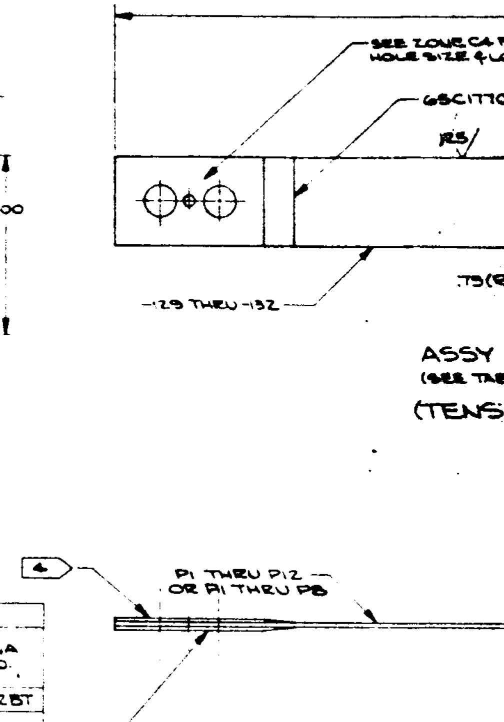


ASSY -49 THRU -58, -60, -61, -62
(SEE TABLE VI & PLY TABLE VI BELOW)
(DOUBLE SHEAR TEST)
(ASSY -61 - DEFECT NO 1 / ASSY -62 - DEFECT NO 2 ENGR REF)
TEST NO. 4 — EWA 1132GT





-41 THRU -46
(SEE TABLE V & PLY TABLE V BELOW)
(INPLANE (RAIL) SHEAR)
TEST #1



ASSY -1
(SEE TABL
(TENSIO

TABLE V

PART NO.	OPEN HOLE SIZE	NO SPECIMENS/TEST (ENGR REF) TEMPERATURE RT	-65°F	+160°F	WET OR DRY	EWA NO.
-41	A	3			W	1132BT
-41	A		3		W	
-41	A			3	W	
-41	A	3			D	
-42	B	3			D	
-43	C	3			D	
-41	A		3		D	
-41	A			3	D	
-44	A	3			W	
-44	A		3		W	
-44	A			3	W	
-44	A	3			D	
-45	B	3			D	
-46	C	3			D	
-44	A		3		D	
-44	A			3	D	1132BT

PLY TABLE V

PART NO.	PLY NO P	MAT'L & SPEC	CLOTH WARP ORIENTATION
-41, -42, -43	1, 3, 6, 8, 10, 12	1	+45°
	2, 4, 5, 7, 9, 11		-45°
-44, -45, -46	1, 8, 12		+45°
	2, 6, 11		0°
	3, 5, 10		-45°
	4, 7, 9		90°

TABLE VI

ASSY NO.	STRAP PART NO.	t_1 (REF)	PLATE PART NO.	t_2 (REF)	LENGTH A	WIDTH W	S	P	e	LENGTH B	STATIC RT	STATIC HOT	STATIC COLD	FAT RT	FAT HOT	FAT COLD	WET OR DRY	LENGTH C
-49	-85	.09	-103	.18	14.67	2.28	.29	.57	.29	1.41	3			3			D	7.21
-50	-86		-104		19.23	3.80	.48	.95	.29	1.41	3 3			3 3			D W	9.49
-51	-87		-105		23.79	5.32	.67	1.33	.29	1.41	3			3			D	11.77
-52	-88		-106		15.05	2.28	.29	.57	.48	2.17	3			3			D	7.40
-53	-89		-107		19.61	3.80	.48	.95	.48	2.17	3 3	3 3	3 3	3 3	3 3	3 3	D W	9.68
-54	-90		-108		24.17	5.32	.67	1.33	.48	2.17	3			3			D	11.96
-55	-91		-109		15.43	2.28	.29	.57	.67	2.93	3			3			D	7.59
-56	-92		-110		19.99	3.80	.48	.95	.67	2.93	3 3			3 3			D W	9.87
-57	-93	.09	-111	.18	24.55	5.32	.67	1.33	.67	2.93	3			3			D	12.15
-58	-94	.06	-112	.12	19.61	3.80	.48	.95	.48	2.17	3			3			D	9.68
-58	-94	.06	-112	.12	19.61	3.80	.48	.95	.48	2.17	3			3			W	9.68
-60	-96	.12	-114	.24	19.61	3.80	.48	.95	.48	2.17	3			3			W	9.68
-60	-96	.12	-114	.24	19.61	3.80	.48	.95	.48	2.17	3			3			D	9.68
-61	-117 -97	.09	-115	.18	19.61	3.80	.48	.95	.48	2.17	3 3			3 3			D W	9.68
-62	-118 -98	.09	-116	.18	19.61	3.80	.48	.95	.48	2.17	3 3			3 3			D W	9.68

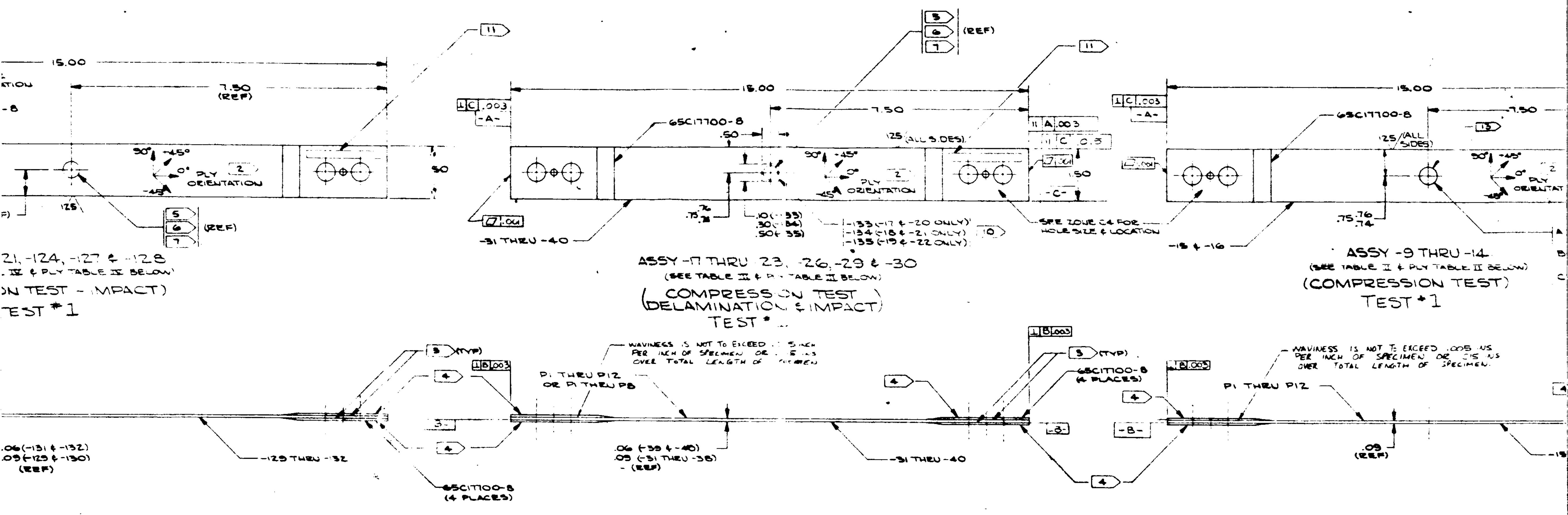
PLY TABLE VI

PART NO.	PLY NO. P	MAT'L & SPEC	CLOTH WARP ORIENTATION
-85, -86, -87, -88, -89, -90, -91, -92, -93, -97, -98, -117, -118	1, 8, 12	1	+45°
	2, 6, 11		0°
	3, 5, 10		-45°
	4, 7, 9		90°
-94	1, 8	1	+45°
	2, 7		0°
	3, 6		-45°
	4, 5		90°
-96, -?2	1, 5, 12, 16	1	+45°
	2, 6, 11, 15		0°
	3, 7, 10, 14		-45°
	4, 8, 9, 13		90°
-103, -104, -105, -106, -107, -108, -109, -110, -111, -115, -116	1, 5, 9, 16, 20, 24	1	+45°
	2, 6, 10, 15, 19, 23		0°
	3, 7, 11, 14, 18, 22		-45°
	4, 8, 12, 13, 17, 21		90°
-114	1, 5, 9, 13, 20, 24, 28, 32	1	+45°
	2, 6, 10, 14, 19, 23, 27, 31		0°
	3, 7, 11, 15, 18, 22, 26, 30		-45°
	4, 8, 12, 16, 17, 21, 25, 29		90°

ASSY NO.	PART NO.
-121	-129
-121	-129
-121	-129
-121	-129
-124	-130
-124	-130
-124	-130
-124	-130
-127	-131
-128	-132

PART NO	P
-131	
-129	
-132	
-130	

#1



21, -124, -127 & -128
IV & PLY TABLE IV BELOW)
ON TEST - IMPACT)
TEST #1

ASSY -17 THRU 23, -26, -29 & -30
(SEE TABLE III & PLY TABLE III BELOW)
(COMPRESSION TEST DELAMINATION & IMPACT)
TEST #1

ASSY -9 THRU -14
(SEE TABLE II & PLY TABLE II BELOW)
(COMPRESSION TEST)
TEST #1

TABLE IV

TYPE DEFECT (REF)	NO. SPECIMENS/TEST (ENGR REF) TEMPERATURE RT	-65°F	+160°F	WET OR DRY	EWA NO.
5	3			W	1.328T
5	↑			D	↑
6				D	
7				D	
5				W	
5				D	↓
6				D	
7				D	
5	↓			D	↓
5	3			D	1.328T

PLY TABLE IV

PLY NO. P	MAT'L & SPEC	CLOTH WARP ORIENTATION
3, 6, 8	1	+45°
4, 5, 7		-45°
3, 5, 8, 10, 12	1	+45°
2, 4, 6, 7, 9, 11		-45°
1, 8	1	+45°
2, 7		0°
3, 6		-45°
4, 5		90°
1, 8, 12	1	+45°
2, 6, 11		0°
3, 5, 10		-45°
4, 7, 9		90°

#2

TABLE III

TYPE OF TEST	ASSY NO.	PART NO.	TYPE DEFECT	NO. SPECIMENS/TEST (ENGR REF) TEMPERATURE RT	-65°F	+160°F	WET OR DRY	EWA NO.
DELAM	-18	-32	-134	3			W	1.328T
↑	-17	-31	-133	↑			D	↑
	-18	-32	-134				D	
	-19	-33	-135				D	
	-21	-35	-134				W	
	-20	-34	-133				D	
↓	-21	-35	-134				D	
DELAM	-22	-36	-135				D	
IMPACT	-23	-37	5				W	
↑	-23	-37	5				D	
	-23	-37	6				D	
	-23	-37	7				D	
	-26	-38	5				W	
	-26	-38	5				D	
	-26	-38	6				D	
	-26	-38	7				D	
↓	-28	-39	5	↓			D	↓
IMPACT	-30	-40	5	3			D	1.328T

PLY TABLE III

PART NO.	PLY NO. P	MAT'L & SPEC	CLOTH WARP ORIENTATION
-30	1, 3, 6, 8	1	+45°
	2, 4, 5, 7		-45°
-31, -32, -33, -37	1, 3, 5, 8, 10, 12	1	+45°
	2, 4, 6, 7, 9, 11		-45°
-40	1, 8	1	+45°
	2, 7		0°
	3, 6		-45°
	4, 5		90°
-34, -35, -36, -38	1, 8, 12	1	+45°
	2, 6, 11		0°
	3, 5, 10		-45°
	4, 7, 9		90°

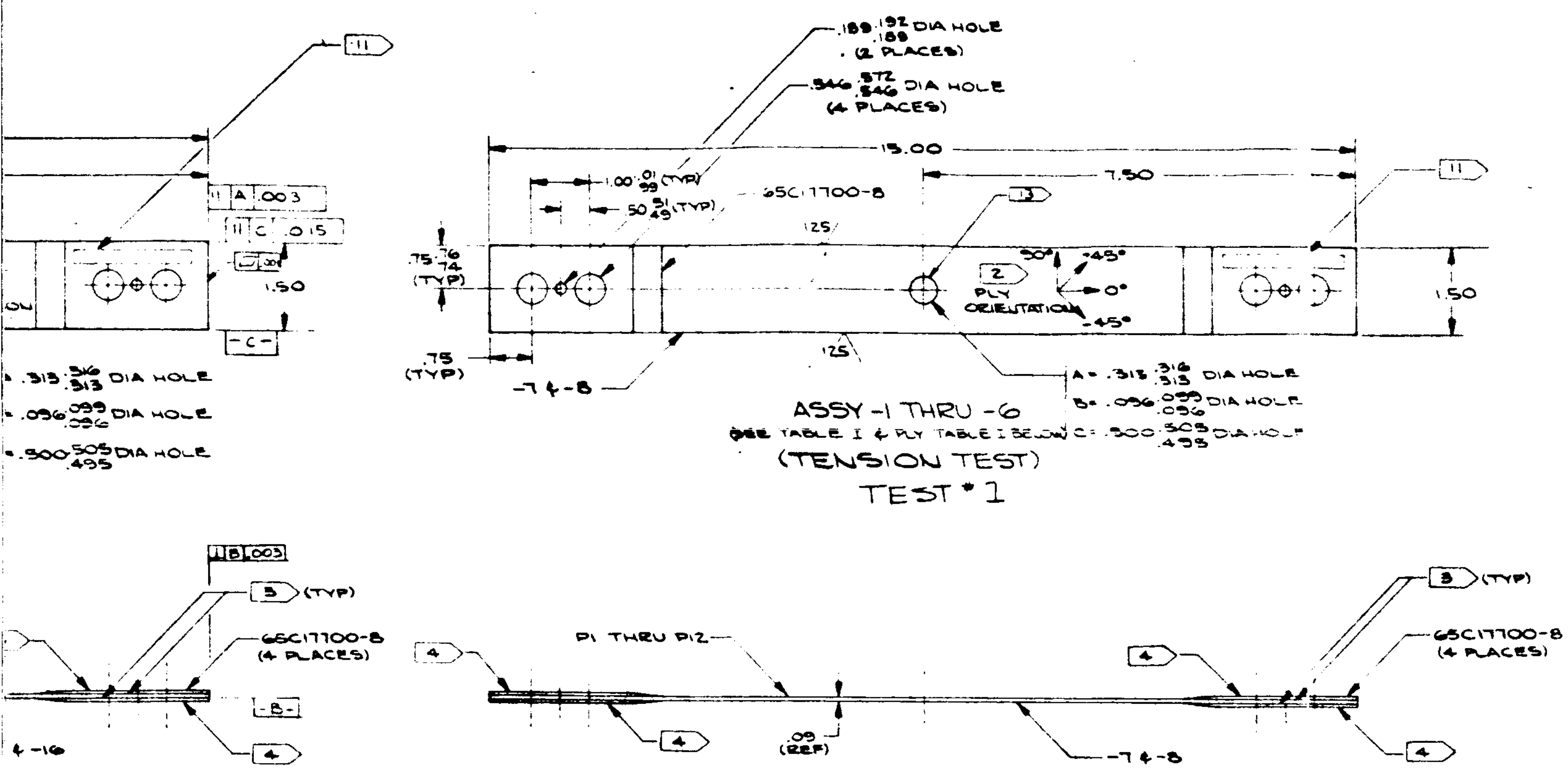
TABLE II

ASSY NO.	PART NO.	OPEN HOLE SIZE	NO. SPECIMENS/TEST (ENGR REF) TEMPERATURE RT	-65°F	+160°F	WET OR DRY
-9	-15	A	3			W
-9	↑	A		3		W
-9		A			3	W
-9		A	3			D
-10		B	3			D
-11		C	3			D
-9	↓	A		3		D
-9	-15	A			3	D
-12	-16	A	3			W
-12	↑	A		3		W
-12		A			3	W
-12		A	3			D
-13		B	3			D
-14		C	3			D
-12	↓	A		3		D
-12	-16	A			3	D

PLY TABLE II

PART NO.	PLY NO. P	MAT'L & SPEC	CLOTH WARP ORIENTATION
-15	1, 3, 5, 8, 10, 12	1	+45°
	2, 4, 6, 7, 9, 11		-45°
-16	1, 8, 12		+45°
	2, 6, 11		0°
	3, 5, 10		-45°
	4, 7, 9		90°

65C17702 2



EWA NO.
1132BT
1132BT

TABLE I							
ASSY NO.	PART NO.	OPEN HOLE SIZE	NO. SPECIMENS/TEST (ENGR REF) TEMPERATURE RT	-65°F	+160°F	WET OR DRY	EWA NO
-1	-7	A	3			W	1132BT
-1		A		3		W	
-1		A			3	W	
-1		A	3			D	
-2		B	3			D	
-3		C	3			D	
-1		A		3		D	
-1	-7	A			3	D	
-4	-8	A	3			W	
-4		A		3		W	
-4		A			3	W	
-4		A	3			D	
-5		B	3			D	
-6		C	3			D	
-4		A		3		D	
-4	-8	A			3	D	1132BT

PLY TABLE I			
PART NO.	PLY NO. P	MATL & SPEC	CLOTH WARP ORIENTATION
-7	1, 3, 5, 8, 10, 12	1	+45°
	2, 4, 6, 7, 9, 11		-45°
-8	1, 8, 12	1	+45°
	2, 6, 11		0°
	3, 5, 10		-45°
	4, 7, 9		90°

#3

FASTENER SYMBOL CODE

FORM, PUNCH, STRAIGHTEN & FIT METAL PARTS PER BAC 5300
BOLT & NUT INSTALLATION PER BAC 5009
MATERIAL SUBSTITUTION & EQUIVALENTS PER BAC 5001
LIST MATERIALS SUBSTITUTIONS & MANUFACTURING PROCESSES PER D6-19736
PART MARKING PER BAC 5307
SEE BAC 5307 FOR SURFACE ROUGHNESS
FOR FINISH CODES, SEE DOCUMENT D3-5000 & OR D6-5000

DIMENSIONING & TOLERANCING PER USAS Y14.5
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES: ANGLES ± 2° DECIMALS ± .03
RIVET & BOLT EDGE MARGINS ± .05
SHEET METAL CORNER RADII
INTERNAL 1/16 EXTERNAL 1/32
BEND RADII

USED ON TEST ONLY

SEE SHEET 1 OR PL FOR LIST OF MATERIAL, USAGE AND NOTES

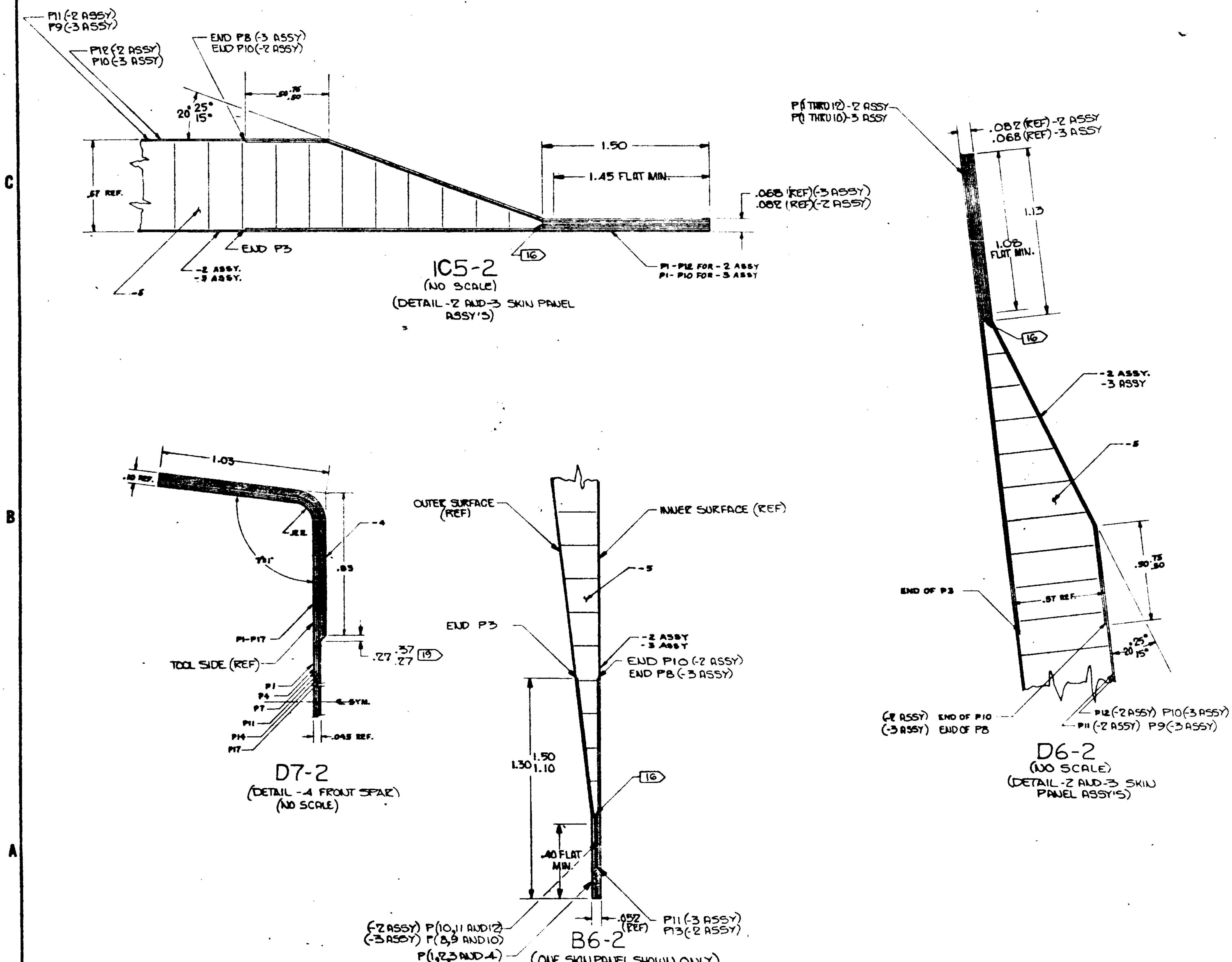
THE BOEING COMPANY
COMMERCIAL AIRPLANE DIVISION RENTON, WASH.

NASA TEST SPECIMENS-MATERIAL ALLOWABLES ADVANCED COMP ELEVATOR

CODE IDENT NO 81205 J 65C17702

A-5

65C17702 REV 2



PART No.
-2
-3
-4
-12

#1

65C17705 | 1

1.ᴍᴇ 65C17705

GENERAL NOTES:
1. INSTALL ALL BACC30M COLLARS WITH BACW10BK()L WASHERS UNDER COLLAR.

2. INSTALL 5/32 DIA FASTENER IN .1635-.1665/.1635 DIA HOLE.
INSTALL 3/16 DIA FASTENER IN .1895-.1925/.1895 DIA HOLE.

LY No. "-P"	MAT'L.	CLOTH WARP OR TAPE ORIENTATION	SPLICE	REV LTR
	2	90°	3	
AND 12	1	+45°	14	
AND 10	1	0°	14	
AND 13	1	-45°	4	
,7 AND 8	1	0°	4	
	2	90°	4	
	2	90°	3	
AND 10	1	+45°	14	
AND 8	1	0°	14	
AND 11	1	-45°	4	
AND 6	1	0°	4	
	2	90°	4	
,11 AND 17	1	+45°	14	
,5,6,8,9 ,13,15 AND 16	13	0°	4	
AND 14	1	-45°	14	
AND 5	1	+45°	NONE	
AND 4	1	-45°	NONE	

1. EPOXY PREIMPREGNATED GRAPHITE WOVEN FABRIC PER XBMS 8-212 TYPE II, CLASS 2 STYLE 3K-70-P FABRICATE PER XBAC 5562. SEE PLY TABLE FOR USAGE.

2. EPOXY PREIMPREGNATED GRAPHITE UNIDIRECTIONAL TAPE TYPE II, CLASS I, GRADE 95 PER XBMS 8-212 FABRICATE PER XBAC 5562. SEE "PLY TABLE" FOR USAGE.

3. BUTT SPLICE PER XBAC5562, EXCEPT OVERLAP OF .10 ± .10 INCHES.

4. BUTT SPLICE PER XBAC5562 MAX. GAP OF .06 ± .06

5. BMS 8-124 CLASS IV, TYPE V, GRADE 3.0 H/C CORE (1/8 CELL NOMEX)

6. PLY ORIENTATION CONVENTION: FABRIC: 0° IS PARALLEL TO THE WARP DIRECTION. TAPE: 0° IS PARALLEL TO THE FIBER DIRECTION.

7. BOND ASSY -2 Ȼ -3 TOGETHER PER BAC5010 TYPE 44.

8. HOLLOW ENDED TI-ALLOY RIVETS. (SEE TONY COLLINS FOR INSTALLATION, 237-1660)

9. APPLY ONE LAYER OF TEDLAR FILM (PVF), TRANSPARENT, 100 BG 30 TR, PER BAC5470 SECTION 7.5K ON THE OUTER SURFACE OF THE INNER FACE SHEET, EXCEPT THE AREA TO BE BONDED BY F/N 7.

10. "TEE" AVAILABLE IN ASTM A36 MATERIAL ANNEALED OR NORMALIZED CONDITION (CONTACT: CHUCK BEISEL 237-1026).

11. USE FILLER METAL PER MIL-R-5632, TYPE I OR 6130 PER AMS 6461

12. INSTALL BACN10JR3CFM WITH TWO BACR15DR3A RIVETS

13. EPOXY PREIMPREGNATED GRAPHITE UNIDIRECTIONAL TAPE TYPE II, CLASS 1, GRADE 145 PER XBMS 8-212 FABRICATE PER XBAC 5562. SEE "PLY TABLE" FOR USAGE.

14. LAP SPLICE PER XBAC 5562.

15. 4130 STEEL SHEET OR PLATE PER MIL-S-18729 ANNEALED OR NORMALIZED CONDITION.

16. FILLER PLIES TO BE BUTTED TO CORE WITH AN OVERLAP OF .00 TO +.20 INCHES TO PROVIDE A SMOOTH TRANSITION FROM FLAT AREA TO CORE RAMP.

17. 2024-T3511 EXTRU PER QQ-A-200/3 OR 7075-T6511 EXTRU PER QQ-A-200/11.

18. SHIM WITH PHENOLIC FOR .030 OR GREATER GAP FOR LESS THAN .030 GAP USE LIQUID SHIM (HYSOL) EA 933 USING PROCEDURES IN D6-9794 FOR MIXING AND APPLYING.

19. DROP OFF PLIES AT EQUAL SPACING WITHIN CUT-OFF AREA.

		PART OR IDENTIFYING NUMBER	NOMENCLATURE OR DESCRIPTION	ZONE	MATERIAL AND SPEC
		BAC5975	PROCESS SPEC		
		BAC5423	PROCESS SPEC		
		XBAC 5562	PROCESS SPEC		
✓	1	-16	SHEAR CLIP	D5-2	AND10134-1204 × 6.2
			WELD FILLER METAL		
✓	1	-15	RIB-ACTUATOR	D5-2	.063 × 9.6 × 22.0
✓	1	-14	SHEAR CLIP	D12-2	AND10133-1001 × 6.2
-12	1	-13	CORE	D14-2	.24 × 6.3 × 21.0
✓	1	-12	RIB-OUTBD.	B12-2	1
-9	2	-11	PLATE	D3-2 D4-2	.2 × 1.0 × 2.6 15
-9	1	-10	PLATE	D3-2	.3 × 3.2 × 6.4 15
✓	1	-9	HINGE FTG. ASSY.	D3-2	
-6	2	-8	PLATE	B5-2	.2 × 1.0 × 2.5 15
-6	1	-7	TEE	B5-2	10 .3 × 1.7 × 2.5 TEE
✓	2	-6	HINGE FTG. ASSY.	D5-2 D12-2	
-2 Ȼ -3	1	-5	CORE	C7-2	.55 × 28.0 × 64.0
✓	1	-4	FRONT SPAR	D7-2	.10 × 8.6 × 66.0
✓	1	-3	SKIN PANEL ASSY. (LOWER)	A10-2	30.0 × 66.0
✓	1	-2	SKIN PANEL ASSY. (UPPER)	A10-2	30.0 × 66.0
—	—	-1	ELEVATOR BOX ASSY.	B9-2	
-1	QTY REQD				

RELEASE — LIST OF MATERIAL

65C17705

#2

2

1

...ENSIONING & TOLERANCING PER USAS Y14.5
...ART MARKING PER BAC 5307
...EE BACD 2097 FOR SURFACE ROUGHNESS
...FORM, PUNCH, STRAIGHTEN & FIT METAL PARTS PER BAC 5300
...BOLT & NUT INSTALLATION PER BAC 5009
...MATERIAL SUBSTITUTION & EQUIVALENTS PER BAC 5008
...SEE MATERIALS SUBSTITUTIONS & MANUFACTURING PROCESSES PER D6-19736
...FOR FINISH CODES, SEE DOCUMENT D6-5000 &/OR D6-5080

FASTENER SYMBOL CODE

MATL. STD. PER BAC 5004. FLUID TIGHT PER BAC 5047

BASIC CODE — ENCLOSED = FLUID TIGHT; OPEN = STANDARD

XX | XX
DBC | XW

DIA DASH NO
MFD HEAD LOC — N = NEAR SIDE; F = FAR SIDE
SPOT WELD OPT
LENGTH DASH NO.
DIMPLE/CSK INFO — D = DIMPLE; 2 = NO SH DIMPLED; C = CSK INSTRUCTURE; 2 LINES TOP = MFD HD; BOTTOM = DRIVEN HD

NOTE: PROTRUDING HD RIVETS DRIVEN FLUSH. D/C INFO (2 LINES) APPLIES TO DRIVEN HD ONLY

HOLE LOCATION FOR 1/16 DIAMETER RIVET
HOLE LOCATION FOR 1/16 DIAMETER BOLT

XTO = BACB30NW( )C( )+	BACC 30 M( )
XTJ = BACB30NY( )C( )	PLUS BACC30( )

REVISIONS

SYM	ZONE	DESCRIPTION	DATE	APPROVAL

...EE BACD 2022 FOR WELD SYMBOL EXPLANATION.
...ELD PER BAC5975 CLASS B. PREHEAT & INTERPASS HEATING REQD
...AGNETIC PARTICLE INSPECT PER BAC5424

...✓ FINISH MACHINED SURFACE. } TYP -6 AND -9 ASSY'S.
...REAK ALL SHARP CORNERS AND EDGES

SEE BACD 2022 FOR WELD SYMBOL EXPLANATION.

FINISHED GRAPHITE EPOXY SPECIMENS SHOULD HAVE SMOOTH, SHARP CUT EDGES, SQUARE CORNERS & SQUARE EDGES WITH NO TAPERED OR FEATHERED EDGES

C

B

ON DWG	
NA	
SH	1

65C17705

...TIFICATION	HT TR	FINISH	PT MK	REV LTR
...LG 17			M	
17				
5			M	
...LG. 17			M	
5			M	
			M	
			M	
			M	
			M	
			M	
...6.2 LG.			M	
			M	
5			M	
15			M	
2		9	M	
		9	M	
6			M	

1-20

1-10

#3

A

NEXT ASSY	USED ON	SECT NO	SERIAL NUMBER	PART NUMBER	RELEASE COLUMN INDICATOR	DRAWING SHEET NUMBER	REV LTR
—	TEST ONLY						

APPLICATION

CHANGE NO	EWA 1211ET
DWG ORIG BY (GROUP)	ADVANCE COMPOSITE

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES: ANGLES ±2° DECIMALS ±.03
RIVET & BOLT EDGE MARGINS ±.05
SHEET METAL CORNER RADII: INTERNAL .16 .19/.16; EXTERNAL .22 .25/.20
BEND RADII: ±.01 ON .03 & .06; ±.03 ON .09 & GREATER

DRAWN	R.J.R. L R HELGESON	DATE 7-7-77
CHECKED		7-27-77
STRESS		7-27-77
ENGR		7-21-77
GROUP		7/27/7
PROJ		7-27-7
		7-27-7

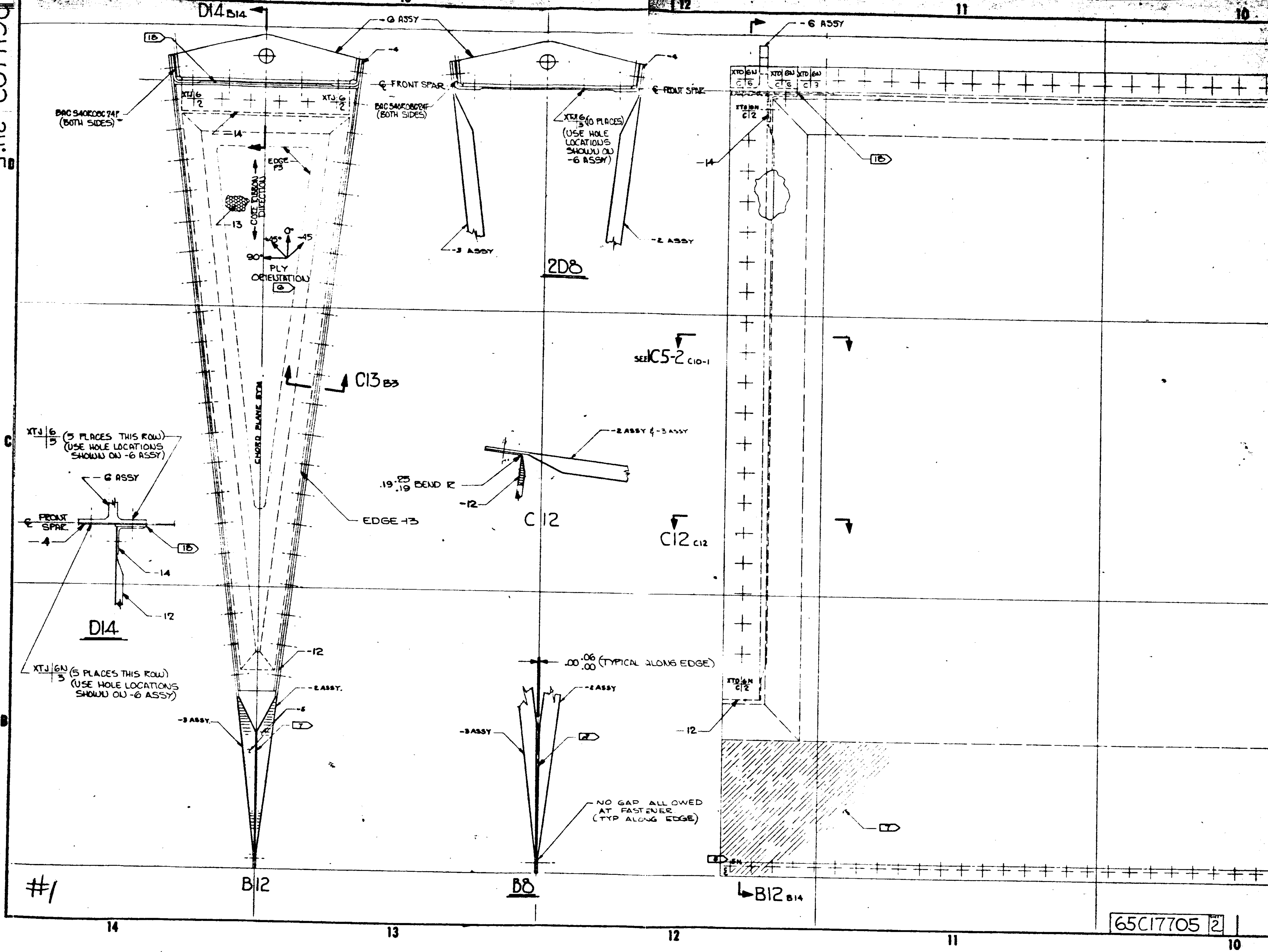
THE **BOEING** COMPANY
COMMERCIAL AIRPLANE DIVISION RENTON, WASH

NASA SONIC TEST BOX
727 ELEVATOR
(TEST Nº 15)

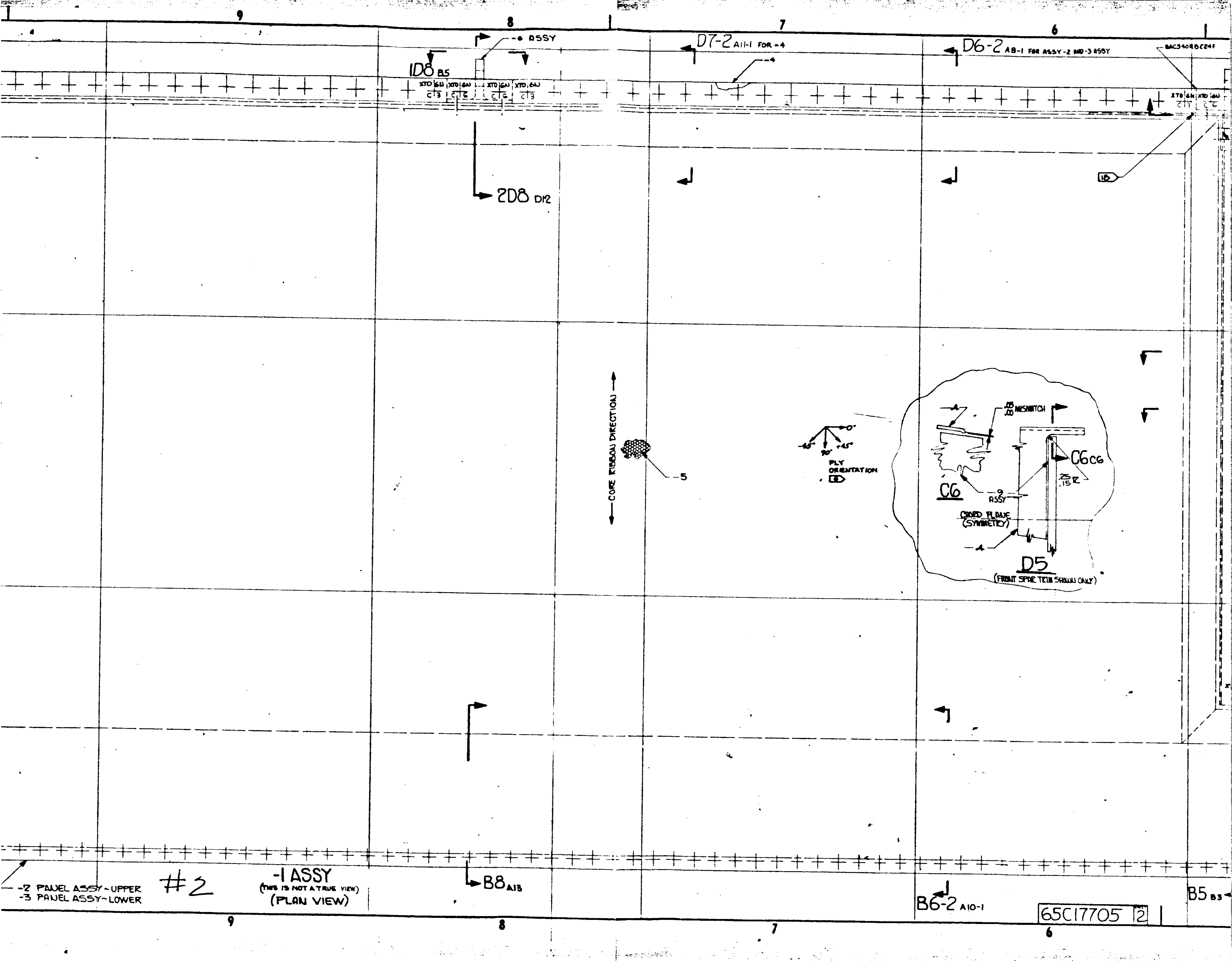
CODE IDENT NO	SIZE	
81205	J	65C17705
SCALE NONE		SH OF 2

DRAWING RECORDS CLERK

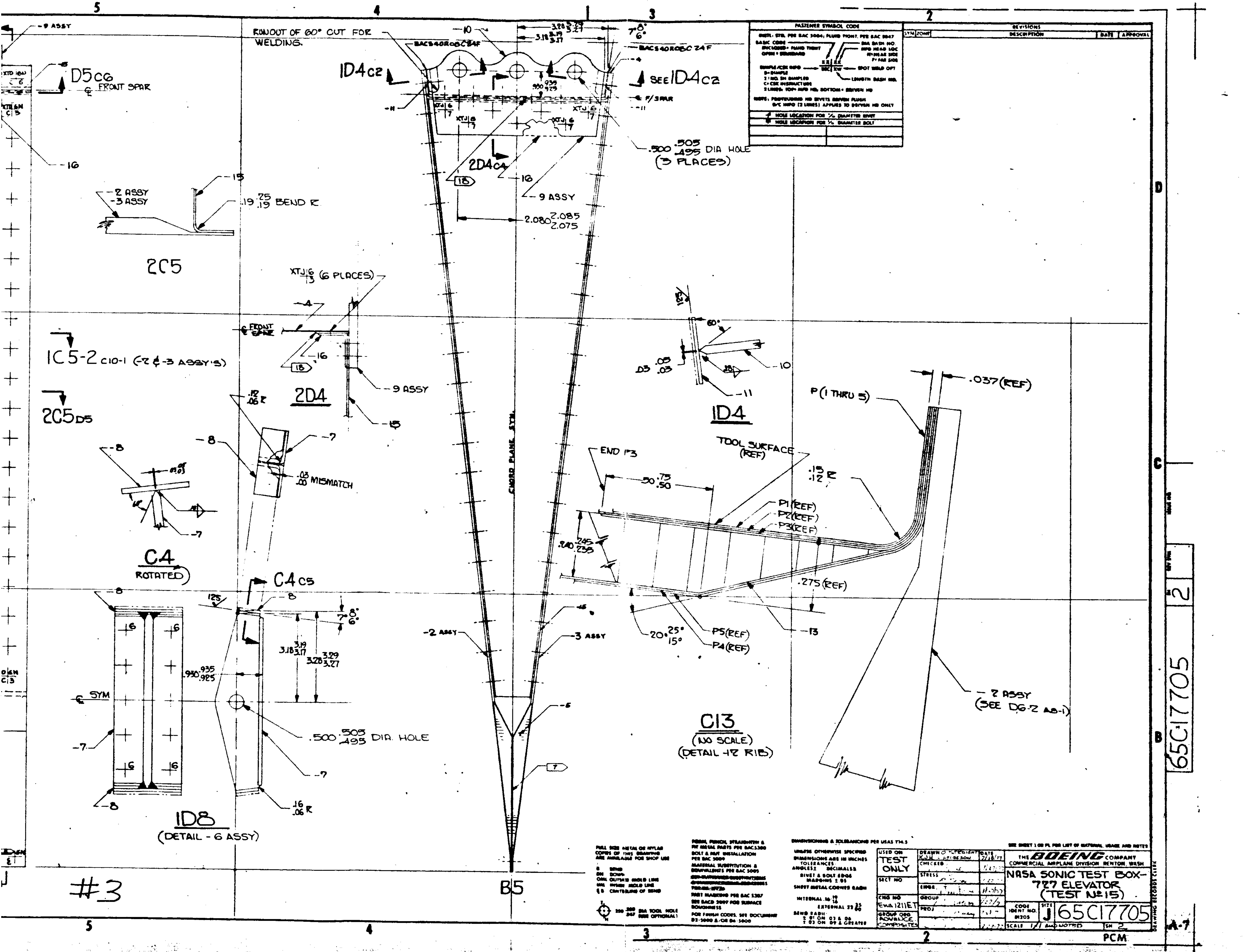
A-6



D14 B14
-6 ASSY
-4
℄ FRONT SPAR
BAC S40R08C24F (BOTH SIDES)
XTJ 6/2
-14
EDGE P3
CORE RIBBON DIRECTION
-13
0°
+45°
-45
90°
PLY ORIENTATION
6
CHORD PLANE SYM
C13 B3
EDGE -13
-12
-2 ASSY.
-3 ASSY.
-5
7
B12
XTJ 6/3 (10 PLACES) (USE HOLE LOCATIONS SHOWN ON -6 ASSY)
-3 ASSY
-2 ASSY
2D8
-2 ASSY & -3 ASSY
.19 .25/.19 BEND R
C12
.00 .06/.00 (TYPICAL ALONG EDGE)
NO GAP ALLOWED AT FASTENER (TYP ALONG EDGE)
B8
XTJ 6/5 (5 PLACES THIS ROW) (USE HOLE LOCATIONS SHOWN ON -6 ASSY)
6 ASSY
℄ FRONT SPAR
-4
18
-14
-12
D14
XTJ 6N/3 (5 PLACES THIS ROW) (USE HOLE LOCATIONS SHOWN ON -6 ASSY)
SEE C5-2 C10-1
C12 C12
XTD 6N C6
XTD 6N C6
XTD 6N C3
XTD 6N C2
18
-14
-12
7
B12 B14
#1
65C17705 2
SH. 5
14
13
12
11
10
D
C
B



-6 ASSY
1D8 B5
2D8 D12
D7-2 A11-1 FOR -4
D6-2 A8-1 FOR ASSY-2 AND-3 ASSY
BAC5408C24F
-4
CORE RIBBON DIRECTION
-5
PLY ORIENTATION
C6
C6 C6
-9 ASSY
MISMATCH
CHORD PLANE (SYMMETRY)
D5
(FRONT SPAR TRIM SHOWN ONLY)
-2 PANEL ASSY-UPPER
-3 PANEL ASSY-LOWER
#2
-1 ASSY
(THIS IS NOT A TRUE VIEW)
(PLAN VIEW)
B8 A13
B6-2 A10-1
B5 B3
65C17705
2


RUNOUT OF 60° CUT FOR WELDING
BACS40R08C24F
1D4C2
SEE 1D4C2
D5C6
℄ FRONT SPAR
.500 .505/.495 DIA HOLE (3 PLACES)
2D4C4
9 ASSY
2.080 2.085/2.075
2 ASSY
3 ASSY
.19 .25/.19 BEND R
2C5
XTJ 6/13 (6 PLACES)
℄ FRONT SPAR
1C5-2 C10-1 (-2 & -3 ASSY'S)
2D4
2C5 D5
.03/.00 MISMATCH
C4
ROTATED
C4 C5
1D8
(DETAIL - 6 ASSY)
.500 .505/.495 DIA. HOLE
℄ SYM
CHORD PLANE SYM.
1D4
.037 (REF)
P (1 THRU 5)
TOOL SURFACE (REF)
END P3
P1 (REF)
P2 (REF)
P3 (REF)
.275 (REF)
P5 (REF)
P4 (REF)
C13
(NO SCALE)
(DETAIL -12 RIB)
2 ASSY (SEE DG-2 A6-1)
B5
#3
FASTENER SYMBOL CODE
REVISIONS
DESCRIPTION
DATE
APPROVAL
USED ON TEST ONLY
THE BOEING COMPANY
COMMERCIAL AIRPLANE DIVISION RENTON, WASH
NASA SONIC TEST BOX-727 ELEVATOR (TEST No 15)
J 65C17705
SCALE 1/1
SH 2
PCM
65C17705

QTY REQD	PART OR IDENTIFYING NUMBER	NOMENCLATURE OR DESCRIPTION	ZONE	MATERIAL AND SPECIFICATION	NT-FR	FINISH	PT-MK	REV LTR

LIST OF MATERIAL

RELEASE

RELEASE

#1

65C17706

SH 1

1. FINISHED GRAPHITE/EPOXY SPECIM[illegible] HAVE SMOOTH, SHARP CUT EDGES, S[illegible] CORNERS & SQUARE EDGES WITH NO FEATHERED EDGES.

2. INSTALL B|6 DIA HI-LOKS IN .1895/1925 [illegible]
B|8 DIA HI-LOKS IN .2495 [illegible]
B|10 DIA HI-LOKS IN .3120 [illegible]

-9	-8	-7	-6	-5	-4	-3		-1	QTY REQD	PART OR IDENTIFYING NUMBER	NOMENCLATURE OR DESCRIPTION	ZONE	MATERIAL AND SPECIFICATION	HT-TR	FINISH	PT-MK	REV LTR
									—	BAC 5470	PROCESS SPEC						
									—	XBAC 5562	PROCESS SPEC						
✓	✓	✓							4	65C17700-8	GRIP DOUBLER	C2.2,C4.2					
			✓	✓	✓	✓		✓	4	65C17700-5	GRIP DOUBLER	C5.2,C7.2					
			✓	✓					1	-14	DEFECT		7			T	
✓	✓	✓							1	-13	PLATE	C3-3	1			T	
			✓	✓	✓	✓		✓	1	-12	ANGLE	C6-2	AND10134-1403; 3.5 LG EXTRU 6	—	F-18 05	T	
			✓	✓	✓	✓			1	-11	PLATE	C6-2	1			T	
								✓	1	-10	PLATE	C6-2	1			T	
—									—	-9	PLATE ASSY TENSION TEST	B3-2					
	—								—	-8	PLATE ASSY TENSION TEST	B3-2				R	
		—							—	-7		B3-2				R	
			—						—	-6		B6-2				R	
				—					—	-5		B6-2				R	
					—				—	-4		B6-2				R	
						—			—	-3		B6-2				R	
												B6-2				R	
								—	—	-1	PLATE ASSY TENSION TEST	B6-2				R	

RELEASE

LIST OF MATERIAL

65C17706

SH 1

#2

ENS SHOULD
QUARE
TAPERS OR

IA HOLE.
.125
.195 DIA HOLE
.3180 DIA HOLE
.3120

1. EPOXY PREIMPREGNATED GRAPHITE WOVEN FABRIC PER XBMS 8-212, TYPE II, CLASS 2, STYLE 3K-70-P. FABRICATE PER BAC 5562. EXCEPT TOLERANCE ON PLY ORIENTATION WILL BE ± 3° & NO SPLICES ALLOWED. SEE APPLICABLE PLY TABLE
2. PLY ORIENTATION CONVENTION
   FABRIC: 0° IS PARALLEL TO THE WARP DIRECTION.
3. BOND GRIP DOUBLER TO GRAPHITE/EPOXY PLATE WITH BMS 5-80, TYPE 2, GRADE 5, CLASS II (BMS 5-51 OPTIONAL) PER BAC 5514-580 (PEEL PLY REQD ON BONDING SURFACE)
4. SANDBLAST THIS SURFACE OF GRIP DOUBLER LIGHTLY AS REQUIRED TO IMPROVE GRIP CAPABILITY.
5. INSTALL ALL BACC30M() COLLARS WITH BACW10BX(3)L (FOR 3/16), BACW10BX(4)L (FOR 1/4), BACW10BY(5)L (FOR 5/16) WASHER UNDER COLLAR.
6. 7075-T6511 PER QQ-A-200/11.
7. TFE FILM PER AMS 3652 .003 THICK
8. PART MARKING LOCATION FOR ASSY NO.
9. INSTALL CENTERED AS SHOWN BETWEEN PLY P6 & P7.
10. X-RAY INSPECT PER QC R&D REQUIREMENTS

DIMENSIONING & TOLERANCING PER USAS Y14.5
PART MARKING PER BAC 5307
SEE BACD 2097 FOR SURFACE ROUGHNESS
FORM, PUNCH, STRAIGHTEN & FIT METAL PARTS PER BAC 5300
BOLT & NUT INSTALLATION PER BAC 5009
~~[illegible]~~
~~[illegible]~~
FOR FINISH CODES, SEE DOCUMENT D2-5000 &/OR D6-5000

FASTENER SYMBOL CODE

INSTL: STD. PER BAC 5004; FLUID TIGHT, PER BAC 5047
BASIC CODE — ENCLOSED = FLUID TIGHT, OPEN = STANDARD
DIA DASH NO.
MFD HEAD LOC: N = NEAR SIDE, F = FAR SIDE
XX | XX
DXC | XW
DIMPLE/CSK INFO — D = DIMPLE, 2 = NO. SH DIMPLED, C = CSK IN STRUCTURE; 2 LINES, TOP = MFD HD; BOTTOM = DRIVEN HD
SPOT WELD OPT
LENGTH DASH NO.
NOTE: PROTRUDING HD RIVETS DRIVEN FLUSH. D/C INFO (2 LINES) APPLIES TO DRIVEN HD ONLY
HOLE LOCATION FOR 1/32 DIAMETER RIVET
HOLE LOCATION FOR 1/16 DIAMETER BOLT
ITD = BACB30NW()C() + BACC30M 5
ITJ = BACB30MY()C() + BACC30M

SYM	ZONE	REVISIONS DESCRIPTION	DATE	APPROVAL

NEXT ASSY	USED ON	SECT NO	SERIAL NUMBER	PART NUMBER	RELEASE COLUMN INDICATOR	DRAWING SHEET NUMBER	REV LTR
APPLICATION							

CHANGE NO. EWM 11326T
DWG ORIG BY (GROUP) ADVANCE COMPOSITES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES: ANGLES ± 2° DECIMALS ± .03
RIVET & BOLT EDGE MARGINS ± .05
SHEET METAL CORNER RADII INTERNAL .16 / .19 / .16
EXTERNAL .22 / .25 / .00
BEND RADII: ± .01 ON .03 & .06; ± .03 ON .09 & GREATER

DRAWN	C STEWART	6-20-77
CHECKED	[illegible]	5-7
STRESS	[illegible]	
ENGR	[illegible]	7-5-7
GROUP	[illegible]	
PROJ	[illegible]	7-7

THE **BOEING** COMPANY
COMMERCIAL AIRPLANE DIVISION RENTON WASH.

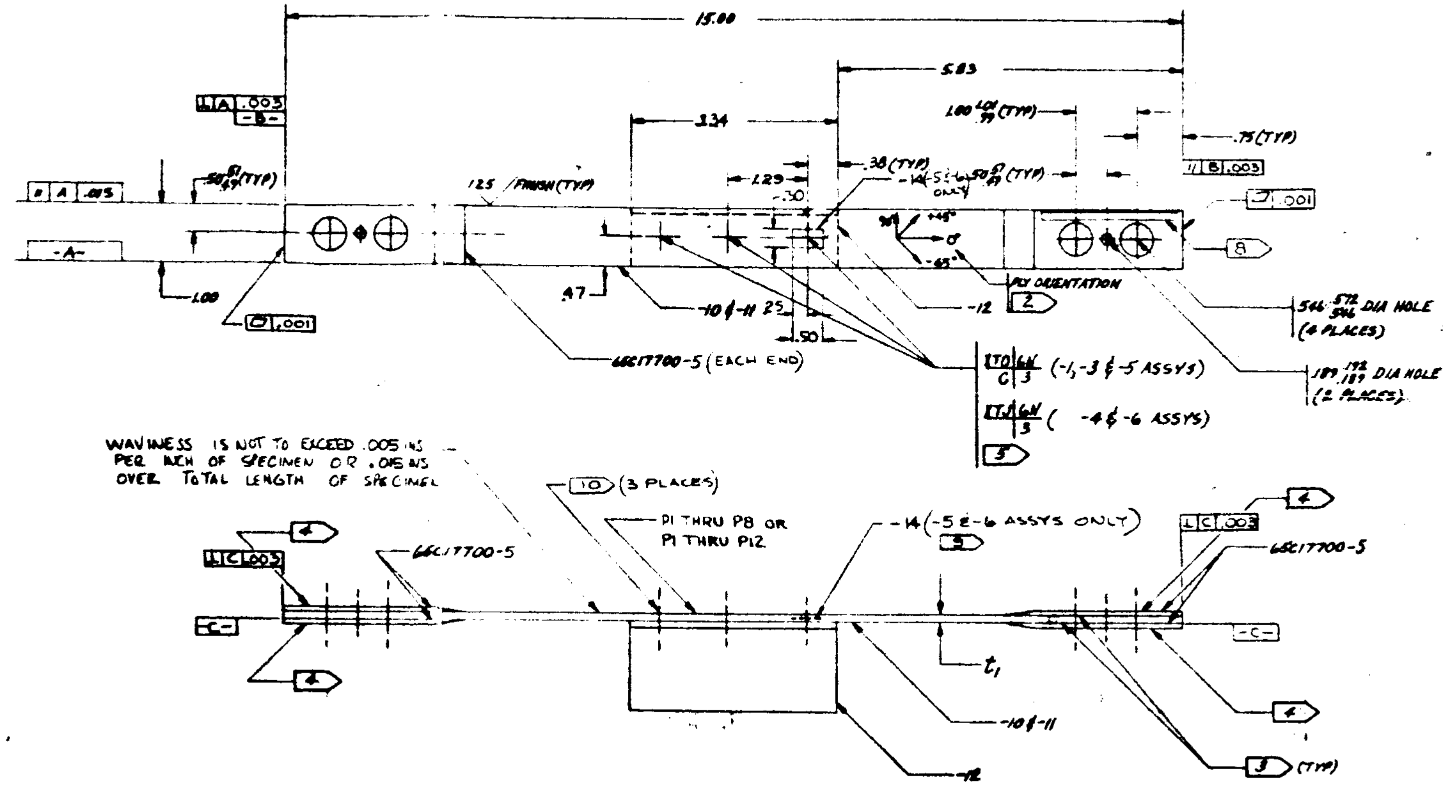
NASA TEST SPECIMENS-MECH SPLICE DESIGN PROPERTIES ADVANCE COMPOSITES, TEST #4

CODE IDENT NO 81205 | SIZE J | 65C17706
SCALE 1/1 | SH 2 OF 2

DRAWING RECORDS CLOSE

65C17706 | SH 1 | RELEASE

#3



ASSY-1 THRU-6
(SEE TABLE 'II' & PLY TABLE 'II' BELOW)
(SIMULATES SPAR TO HINGE FITTING ATTACHMENT)

PLY TABLE 'II'

PART NO.	PLY NO. "P"	MATL & SPEC	CLOTH WARP ORIENTATION
-10	1 & 8	1	+45°
	3 & 6		-45°
	2,4,5,7		0°
-11	1, 8, 12	1	+45°
	3, 5, 10		-45°
	2,4,6,7,9,11		0°

TABLE 'II'

ENGINEERING REF

ASSY NO.	PART NO.	t_1 (REF)	CSK (REF)	NONCSK (REF)	NUMBER OF SPECIMENS REQD: STATIC (TEMPERATURE) RT			FATIGUE (TEMPERATURE) RT			WET or DRY	EWA NO
-1	-10	.060	✓		3			3			D	
-3	-11	.090	✓		3			3			D	
-4	-11	.090		✓	3			3			D	
-5	-11	.090	✓ (REF)		3			3			D	
-6	-11	.090		✓ (REF)	3			3			D	

PLY TABLE 'I'

PART NO.	PLY NO. "P"
-13	1, 8, 12
	3, 5, 10
	2,4,6,7,9,11

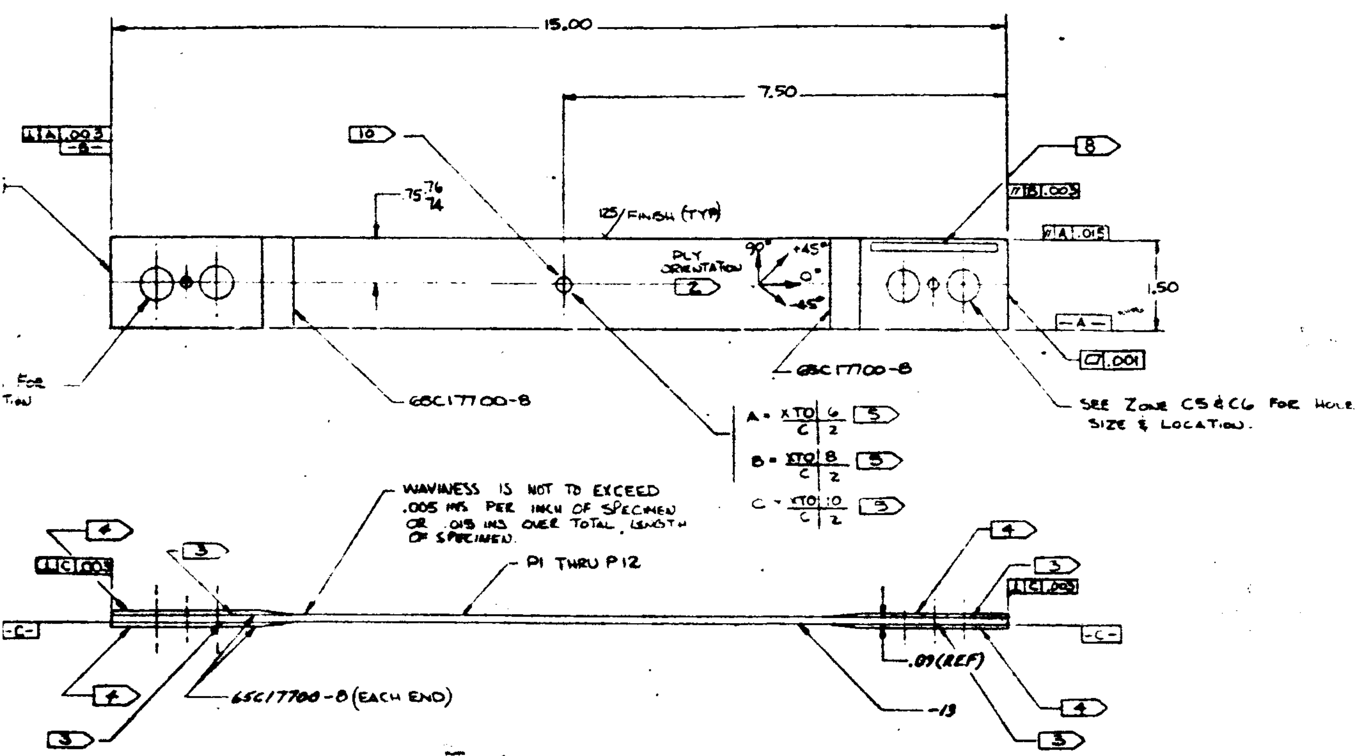
SEE ZONE C8 & C... HOLE SIZE & LOC... 7

#1

65C17706 2

FASTENER SYMBOL CODE

SYM	ZONE	REVISIONS DESCRIPTION	DATE	APPROVAL



(FATIGUE TEST - FILLED HOLE)

ASSY -7, -8 & -9

(SEE TABLE 'I' & PLY TABLE 'I' BELOW)

PLY NO.	SPEC	CLOTH WARP ORIENTATION
1		+45°
		-45°
		0°

TABLE 'I'

ASSY NO.	PART NO.	FAST SIZE			STATIC RT	STATIC -65	STATIC 160	FATIGUE RT	FATIGUE -65	FATIGUE 160	WET OR DRY	EWA NO.
-7	-13	A			3	—	—	3	—	—	D	
-8	-13	B			3	—	—	3	3	3	D	
-9	-13	C			3	—	—	3	—	—	D	
-8	-13	B			3			3	3	3	W	

NUMBER OF SPECIMENS (STATIC/TEMPERATURE, FATIGUE/TEMPERATURE) — ENGINEERING REF CEGD

#2

DIMENSIONING & TOLERANCING PER USAS Y14.5

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES: ANGLES ±2° DECIMALS ±.03. RIVET & BOLT EDGE MARGINS ±.05

USED ON TEST ONLY

DRAWN D. STREIGHT

SEE SHEET 1 OR PL FOR LIST OF MATERIAL, USAGE AND NOTES

THE BOEING COMPANY
COMMERCIAL AIRPLANE DIVISION RENTON, WASH

NASA TEST SPECIMENS - MECH SPLICE
DESIGN PROPERTIES
ADVANCE COMPOSITES, TEST #4

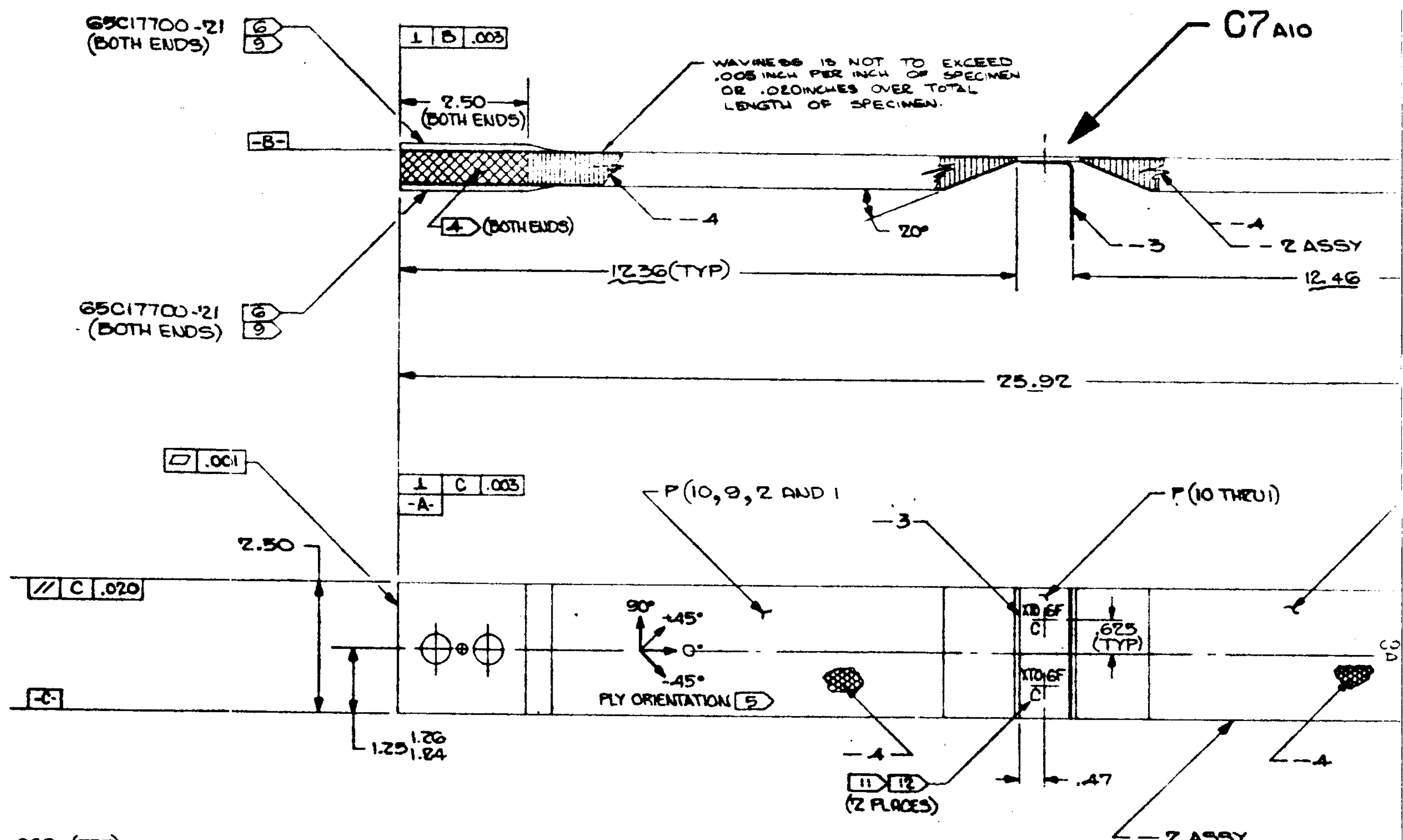
CODE IDENT NO 81205 | SIZE J | 65C17706

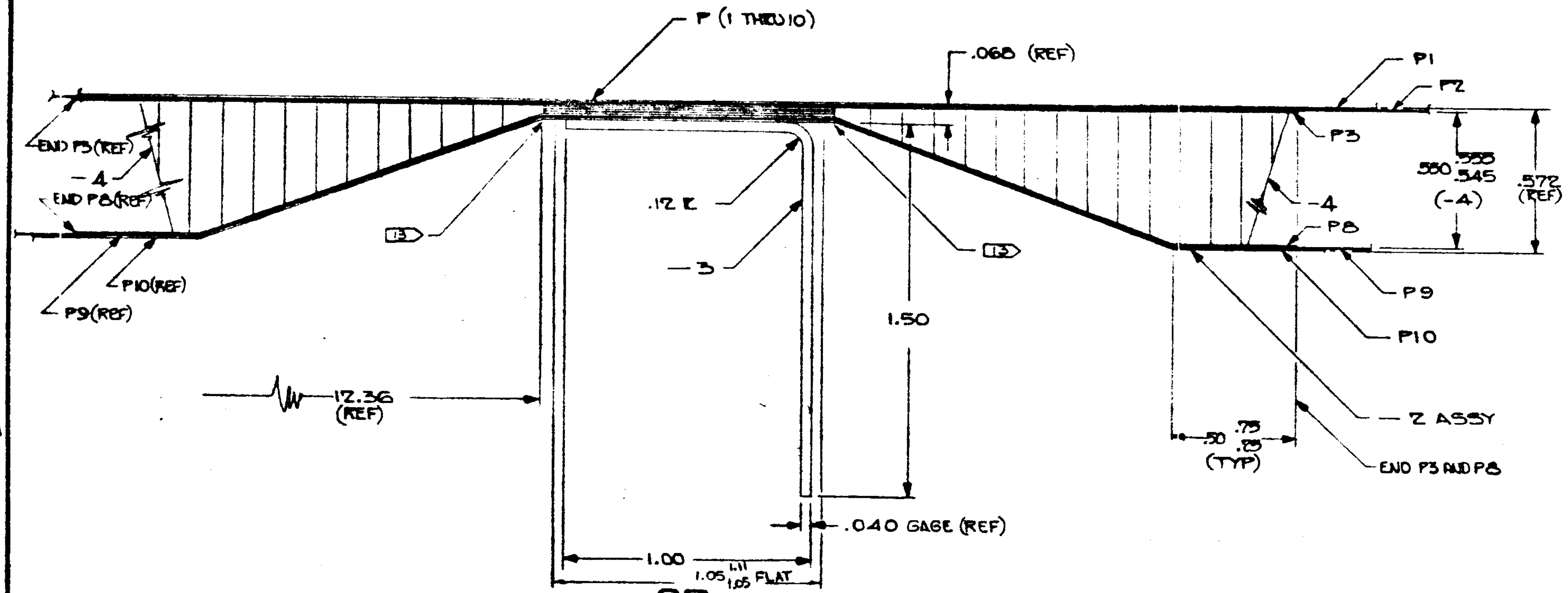
SCALE 1/1 | SH 2

65C17706 | 2

PLY TABLE

PART NUMBER	PLY NUMBER "P"	CLOTH WARP OR TAPE ORIENTATION	MATERIAL	SPLICE	REV. LTR.
-2	2 AND 10	+ 45°	1	NONE	
	1	90°	2	8	
	3,5,6 AND 8	0°	1	NONE	
	4 AND 7	-45°	1	NONE	
	9	90°	2	10	





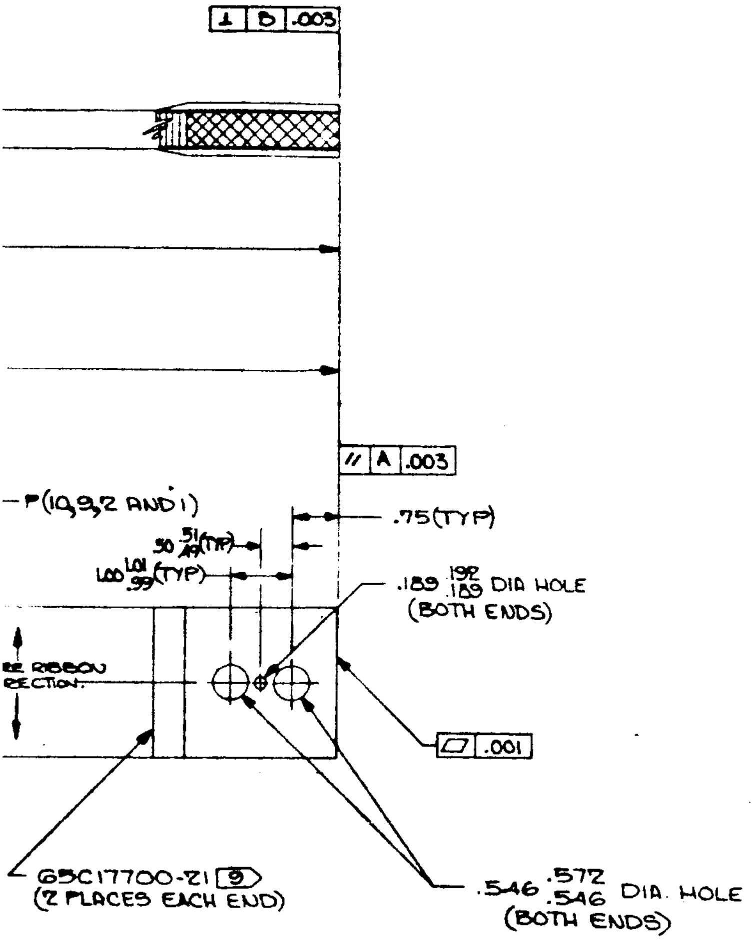
C7
(5/1 SIZE)

#1

-1 ASSEMBLY
(PANEL TO RIB SPECIMEN TEST № 8)

65C17708 T

65C17708 SH. 1



1. EPOXY PREIMPREGNATED GRAPHITE FABRIC PER XBMS 8-212, TYPE II, CLASS 2, STYLE 3K-70-P. FABRICATE PER XBAC 5562. SEE "PLY TABLE" (ZONE C11) FOR USAGE.

2. EPOXY PREIMPREGNATED GRAPHITE UNIDIRECTIONAL TAPE PER XBMS 8-212, TYPE II, CLASS 1, GRADE 95. FABRICATE PER XBAC 5562. SEE "PLY TABLE" (ZONE C11) FOR USAGE.

3. BMS 8-124, CLASS IV, TYPE V, GRADE 3 HONEYCOMB CORE (1/8 INCH CELL NOMEX).

4. POT HONEYCOMB CELLS FULL WITH BMS 5-28, TYPE 12 OVER THIS DIMENSION. CURE AT 350° AND SAND FLUSH WITHIN ±.005.

5. PLY ORIENTATION CONVENTION:
FABRIC: 0° IS PARALLEL TO THE WARP DIRECTION.
TAPE: 0° IS PARALLEL TO THE FIBER DIRECTION.

6. SANDBLAST THIS SURFACE OF GRIP DOUBLER LIGHTLY TO IMPROVE GRIP CAPABILITY.

7. 2024-O SHEET PER QQ-A-250/4.

8. BUTT SPLICE WITH AN OVERLAP OF .10 ± .10 INCHES.

9. BOND 65C17700-21 TO -2 WITH BMS 5-80, TYPE 2, GRADE 5, CLASS II (BMS 5-51 OPTIONAL) PER BAC 5514-580 (PEEL PLY REQUIRED ON BONDING SURFACE).

10. BUTT SPLICE PER XBAC 5562.

11. X-RAY INSPECT HOLE PER QC R&D REQUIREMENTS

12. INSTALL HI-LOKS WITH A BAC W10BX3L (WASHER) UNDER UNDER THE BAC C30M COLLAR.

13. FILLER PLIES TO BE BUTTED TO CORE EDGE WITH AN OVERLAP OF .00 TO +.20 TO PROVIDE A SMOOTH TRANSITION FROM FLAT AREA TO CORE RAMP

FINISHED GRAPHITE/EPOXY SPECIMENS SHOULD HAVE SMOOTH SHARP CUT EDGES, SQUARE CORNERS AND SQUARE EDGES WITH NO TAPERED OR FEATHERED EDGES.

INSTALL 3/16 DIA HI-LOKS IN .1895/.1905 DIA HOLES

HEAT TREAT ALUM. ALLOYS PER BAC 5602.

-2	-1	QTY REQD	PART OR IDENTIFYING NUMBER	NOMENCLATURE OR DESCRIPTION	ZONE	MATERIAL AND SPECIFICATION
	✓	2	BAC W10BX3L	WASHER		
	✓	4	65C17700-21	FIBERGLASS GRIP DBLR	B7	
✓		2	-4	H/C CORE	B7 B8	3 .55 × 2.5 × 1?
	✓	1	-3	ANGLE	C8	7 .040 × 2.5 × 2
—	✓	1	-2	PANEL ASSY	B7	1 2
	—	—	-1	NASA PANEL TO EIB SPECIMEN ASSY (TEST #8)	B8	

RELEASE — LIST OF MATERIAL

65C17708 | T

#2

2 | 1

...ONING & TOLERANCING PER USAS Y14.5
...MARKING PER BAC 5307
...ICD 2097 FOR SURFACE ROUGHNESS
... PUNCH STRAIGHTEN & FIT METAL PARTS ...AC 5300
... NUT INSTALLATION ...AC 5009
...IAL SUBSTITUTION & EQUIVALENTS ...AC 5006
...MATERIALS SUBSTITUTIONS ...MANUFACTURING PROCESSES ...-19736
...FINISH CODES, SEE DOCUMENT ...00 &/OR D6-5000

FASTENER SYMBOL CODE

INSTL STD PER BAC 5004, FLUID TIGHT PER BAC 5047

BASIC CODE — ENCLOSED = FLUID TIGHT, OPEN = STANDARD

DIA DASH NO.

MFD HEAD LOC — N = NEAR SIDE, F = FAR SIDE

XX | XX — DDC | XW

DIMPLE/CSK INFO — D = DIMPLE, 2 = NO. SH DIMPLED, C = CSK INSTRUCTURE

SPOT WELD OPT

LENGTH DASH NO.

2 LINES TOP = MFD HD, BOTTOM = DRIVEN HD

NOTE: PROTRUDING HD RIVETS DRIVEN FLUSH. D/C INFO (2 LINES) APPLIES TO DRIVEN HD ONLY

HOLE LOCATION FOR $\frac{3}{16}$ DIAMETER RIVET

HOLE LOCATION FOR $\frac{3}{16}$ DIAMETER BOLT

XTO-BAC B30NW#C4 PLUS BAC C30M (12)

REVISIONS				
SYM	ZONE	DESCRIPTION	DATE	APPROVAL

C

B

A

...				M	
...	T3			M	
				M	
				RS	
...ION	HT TR	FINISH	PT-MK	REV LTR	

#3

NEXT ASSY	USED ON	SECT NO	SERIAL NUMBER	PART NUMBER	RELEASE COLUMN INDICATOR	DRAWING SHEET NUMBER	REV LTR
	TEST ONLY						

APPLICATION

CHANGE NO: EWA 1211CT

DWG ORIG BY (GROUP): ADVANCE COMPOSITES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES: ANGLES ± 2° DECIMALS ± .03
RIVET & BOLT EDGE MARGINS ± .06
SHEET METAL CORNER RADII: INTERNAL .16 $\frac{19}{16}$; EXTERNAL .22 $\frac{25}{06}$
BEND RADII: .01 ON .03 & .06; .03 ON .09 & GREATER

DRAWN Ken Holing 7/5/77
CHECKED
STRESS
ENGR
GROUP
PROJ
MFG

THE **BOEING** COMPANY
COMMERCIAL AIRPLANE DIVISION RENTON, WASH

NASA PANEL TO RIB SPECIMEN-TEST № 8, 727 ELEVATOR, ADVANCE COMPOSITES

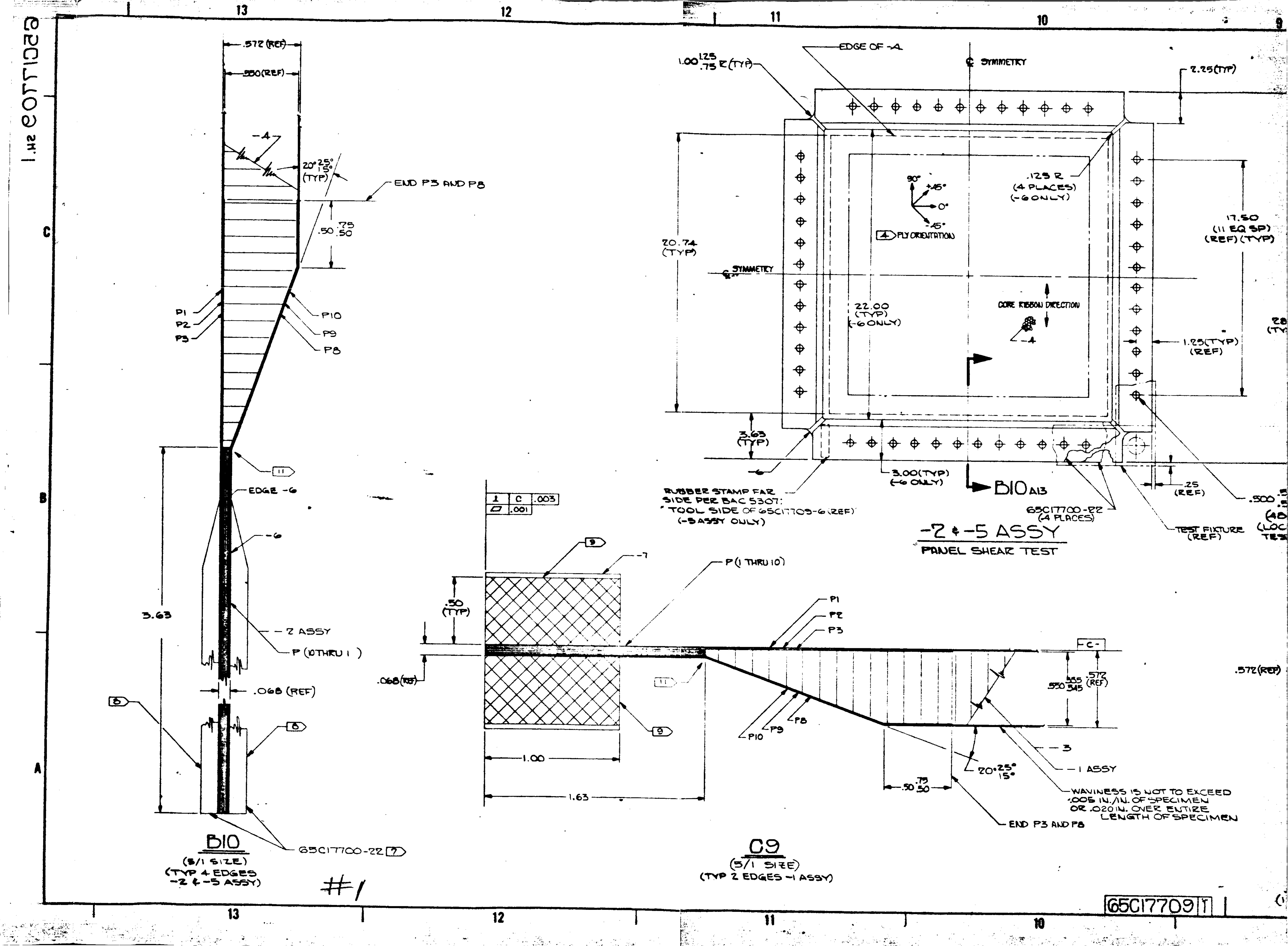
CODE IDENT NO 81205 | SIZE J | 65C17708

SCALE 1/1 AND NOTED | SH 1 OF 1

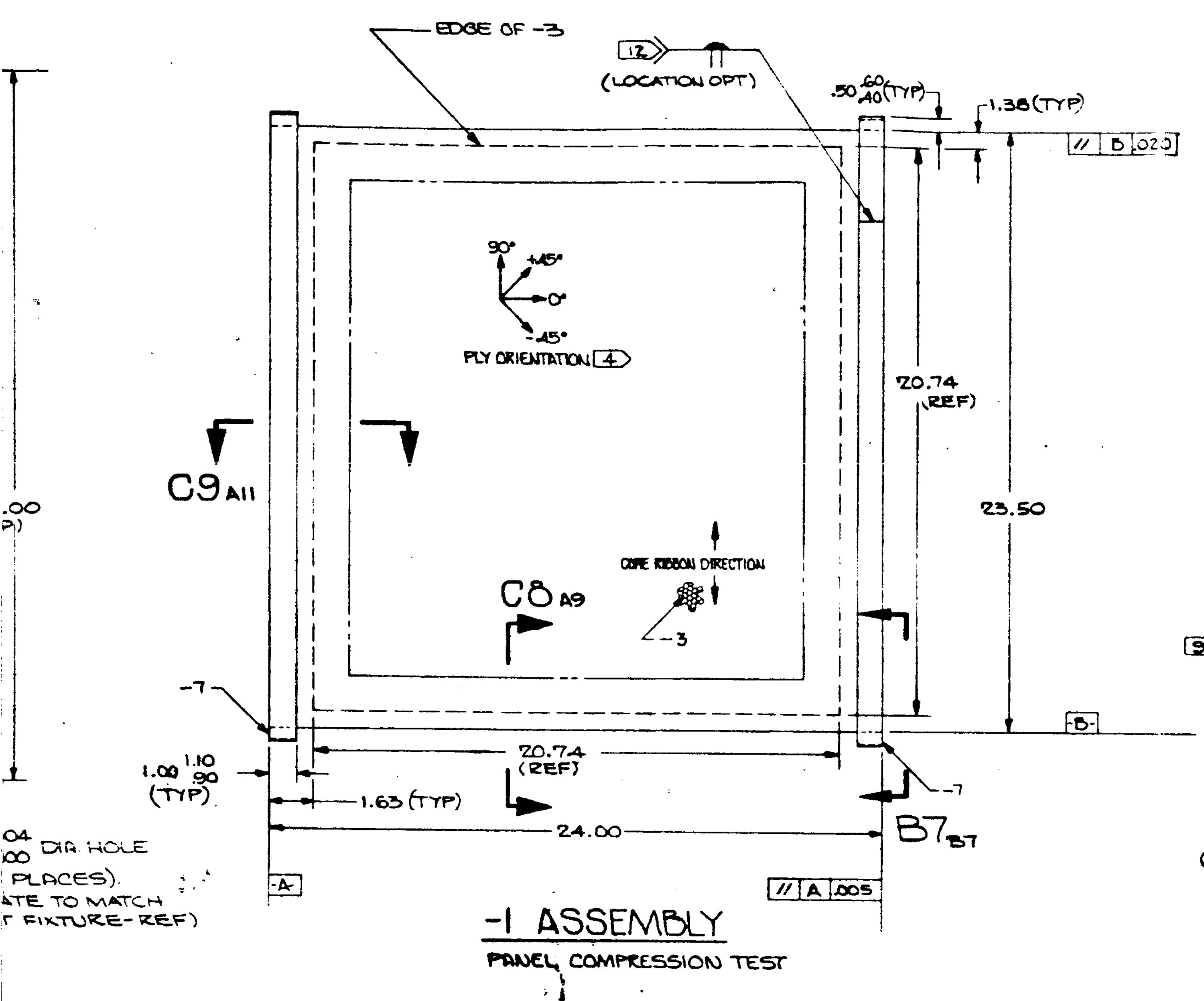
DRAWING RECORDS CLERK

65C17708

A-10

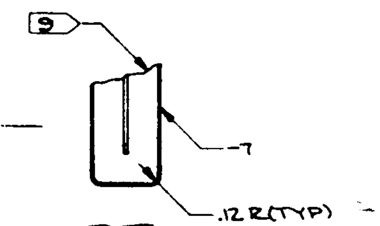


.572 (REF)
.550 (REF)
-4
20° 25° 15° (TYP)
END P3 AND P8
.50 .75 .50
P1
P2
P3
P10
P9
P8
11
EDGE -6
-6
3.63
-2 ASSY
P (10 THRU 1)
.068 (REF)
8
65C17700-22 7
B10
(8/1 SIZE)
(TYP 4 EDGES -2 & -5 ASSY)
#1
1.00 .125 .75 R (TYP)
EDGE OF -4
℄ SYMMETRY
2.25 (TYP)
20.74 (TYP)
℄ SYMMETRY
.125 R (4 PLACES) (-6 ONLY)
90° +45° 0° -45°
4 PLY ORIENTATION
17.50 (11 EQ SP) (REF) (TYP)
22.00 (TYP) (-6 ONLY)
CORE RIBBON DIRECTION
-4
1.25 (TYP) (REF)
3.63 (TYP)
3.00 (TYP) (-6 ONLY)
B10 A13
RUBBER STAMP FAR SIDE PER BAC 5307: "TOOL SIDE OF 65C17709-6 (REF)" (-5 ASSY ONLY)
65C17700-22 (4 PLACES)
.25 (REF)
TEST FIXTURE (REF)
.500
-2 & -5 ASSY
PANEL SHEAR TEST
1 C .003
▱ .001
9
-7
P (1 THRU 10)
.50 (TYP)
.068 (REF)
11
9
1.00
1.63
-C-
.555 .545
.550
.572 (REF)
.572 (REF)
-3
-1 ASSY
20° .25° 15°
.50 .75 .50
WAVINESS IS NOT TO EXCEED .005 IN./IN. OF SPECIMEN OR .020 IN. OVER ENTIRE LENGTH OF SPECIMEN
END P3 AND P8
C9
(5/1 SIZE)
(TYP 2 EDGES -1 ASSY)
65C17709 T
65C17709 SH. 1

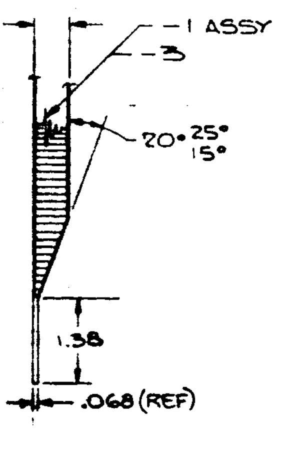


-1 ASSEMBLY

PANEL COMPRESSION TEST



B7
(1/1 SIZE)



C8
(1/1 SIZE)

#2

"PLY TABLE"

PART NUMBER	PLY NUMBER "P"	CLOTH WARP OR TAPE ORIENTATION	MATERIAL	SPLICE	REV LTR
-1	2 AND 10	+45°	1	NONE	
-2	1	90°	2	5	
-6	3,5,6 & 8	0°	1	NONE	
	4 AND 7	-45°	1	NONE	
	9	90°	2	6	

1. EPOXY PREIMPR
TYPE II, CLASS 2
XBAC 5562.
SEE "PLY TAB

2. EPOXY PREIMPRE
XBMS 8-212, TYP
XBAC 5562
SEE "PLY TABL

3. BMS 8-124, CLA
(1/8 INCH CELL N

4. PLY ORIENTATIO
FABRIC:
TAPE:

5. BUTT SPLICE PE

6. BUTT SPLICE P

7. BOND 65C1770
CLASS II (BMS
(PEEL PLY REQ

8. SANDBLAST TH
LIGHTLY TO IMP

9. POTTING COMP

10. APPLY ONE L
PARENT 100
7.5K ON TH
FACE PLY (C
ON -1 ASSY

11. FILLER PLIES
AN OVERLAP
SMOOTH TRA
CORE RAMP

12. FUSION WEL

65C17709 T

65C17709

:GNATED GRAPHITE FABRIC PER XBMS 8-212,
, STYLE 3K-70-P. FABRICATE PER
LE"(ZONE D6) FOR USAGE.

SNATED GRAPHITE UNIDIRECTIONAL TAPE PER
E II, CLASS I, GRADE 95. FABRICATE PER
." (ZONE D6) FOR USAGE.

SS IV, TYPE V, GRADE 3 HONEYCOMB CORE
MEX).

I CONVENTION:
D° IS PARALLEL TO THE WARP DIRECTION.
D° IS PARALLEL TO THE FIBER DIRECTION.

R XBAC 5562, EXCEPT OVERLAP .10 ± .0 INCHES

ER XBAC 5562, .00 - .06 GAP

-22 TO -2 & -6 W/BMS 5-80, TYPE 2, GRADE 5,
5-51 OPTIONAL) PER BAC 5514-580
IRED ON BONDING SURFACE).

IS SURFACE OF 65C17700-22 (GRIP DOUBLER)
ROVE GRIP CAPABILITY.

UND BMS 5-28, TYPE 12, PER BAC 5532.

AYER OF TEDLAR FILM (PVF) TRANS-
BG 30TR PER BAC 5470, SECTION
E OUTER SURFACE OF THE INNER
N P10) EXCEPT POTTING AREA PER [9]
& GRIP AREA ON -2 & -5 ASSY

TO BE BUTTED TO CORE EDGE WITH
OF .00 TO +.20 TO PROVIDE A
NSITION FROM FLAT AREA TO

PER BAC 5975, CLASS C

FINISHED GRAPHITE/EPOXY SPECIMENS SHOULD HAVE SMOOTH SHARP CUT EDGES, SQUARE CORNERS AND SQUARE EDGES, WITH NO TAPERED OR FEATHERED EDGES.

SEE BACD 2022 FOR WELD SYMBOL EXPLANATION

DIMENSIONING & TOLERANCING PER USAS Y14.5
PART MARKING PER BAC 5307
SEE BACD 2091 FOR SURFACE ROUGHNESS
FORM, PUNCH, STRAIGHTEN & FIT METAL PARTS PER BAC 5300
BOLT & NUT INSTALLATION PER BAC 5009
MATERIAL SUBSTITUTION & EQUIVALENTS PER BAC 5001
SEE MATERIALS SUBSTITUTIONS & MANUFACTURING PROCESSES PER D6-19736
FOR FINISH CODES, SEE DOCUMENT D6-5000 &/OR D6-5000

FASTENER SYMBOL CODE
INSTL: STD. PER BAC 5004. FLUID TIGHT PER BAC 5047
BASIC CODE: ENCLOSED = FLUID TIGHT; OPEN = STANDARD — DIA DASH NO; MFD HEAD LOC (N = NEAR SIDE, F = FAR SIDE)
DIMPLE/CSK INFO: D = DIMPLE; 2 = NO. SH DIMPLED; C = CSK INSTRUCTURE; 2 LINES: TOP: MFD HD; BOTTOM: DRIVEN HD — SPOT WELD OPT; LENGTH DASH NO.
NOTE: PROTRUDING HD RIVETS DRIVEN FLUSH; B/C INFO (2 LINES) APPLIES TO DRIVEN HD ONLY
HOLE LOCATION FOR 1/4 DIAMETER RIVET
HOLE LOCATION FOR 1/4 DIAMETER BOLT

REVISIONS				
SYM	ZONE	DESCRIPTION	DATE	APPROVAL

-5	-2	-1	QTY REQD	PART OR IDENTIFYING NUMBER	NOMENCLATURE OR DESCRIPTION	ZONE	MATERIAL AND SPECIFICATION	HT-TR	FINISH	PT-MK	REV LTR
		—	—	XBAC 5562	PROCESS SPEC						
		—	—	BAC 5470	PROCESS SPEC						
		—	—	BAC 5975	PROCESS SPEC						
		—	—	BACD 2022	DESIGN STD						
					WELD FILLER METAL		QQ-R-566, CLASS 4043				
✓	✓		8	65C17700-22	GRIP DOUBLER	B10					
		✓	2	-7	POTTING COVER	B7	.040 x 1.0 x 5.5 2024-T4 QQ-A-250/11	—		M	
✓			1	-6	PANEL	B11	[1] [2]			M	
—			—	-5	PANEL ASSY	B10			[10]	RS	
	✓		1	-4	H/C CORE	C10	[3] .55 x 21.0 x 21.0			M	
		✓	1	-3	H/C CORE	C8	[3] .55 x 20.8 x 20.8			M	
	—		—	-2	NASA H/C PANEL SPECIMEN SHEAR TEST	B10	[1] [2]		[10]	RS	
		—	—	-1	NASA H/C PANEL SPECIMEN COMPRESSION TEST	B8	[1] [2]		[10]	RS	

RELEASE — LIST OF MATERIAL

#3

NEXT ASSY	USED ON	SECT NO	SERIAL NUMBER	PART NUMBER	PLEASE COLUMN	DRAWING SHEET NUMBER	REV LTR
	TEST ONLY						

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES: ANGLES: ± 2° DECIMALS: .03
RIVET & BOLT EDGE MARGINS: ± .05
SHEET METAL CORNER RADII: INTERNAL 1/16, EXTERNAL
BEND RADII: .01 ON .03 & .06; .03 ON .09 & GREATER

CHANGE NO. EWA 1211 HT
DWG ORIG BY (GROUP) ADVANCE COMPOSITES

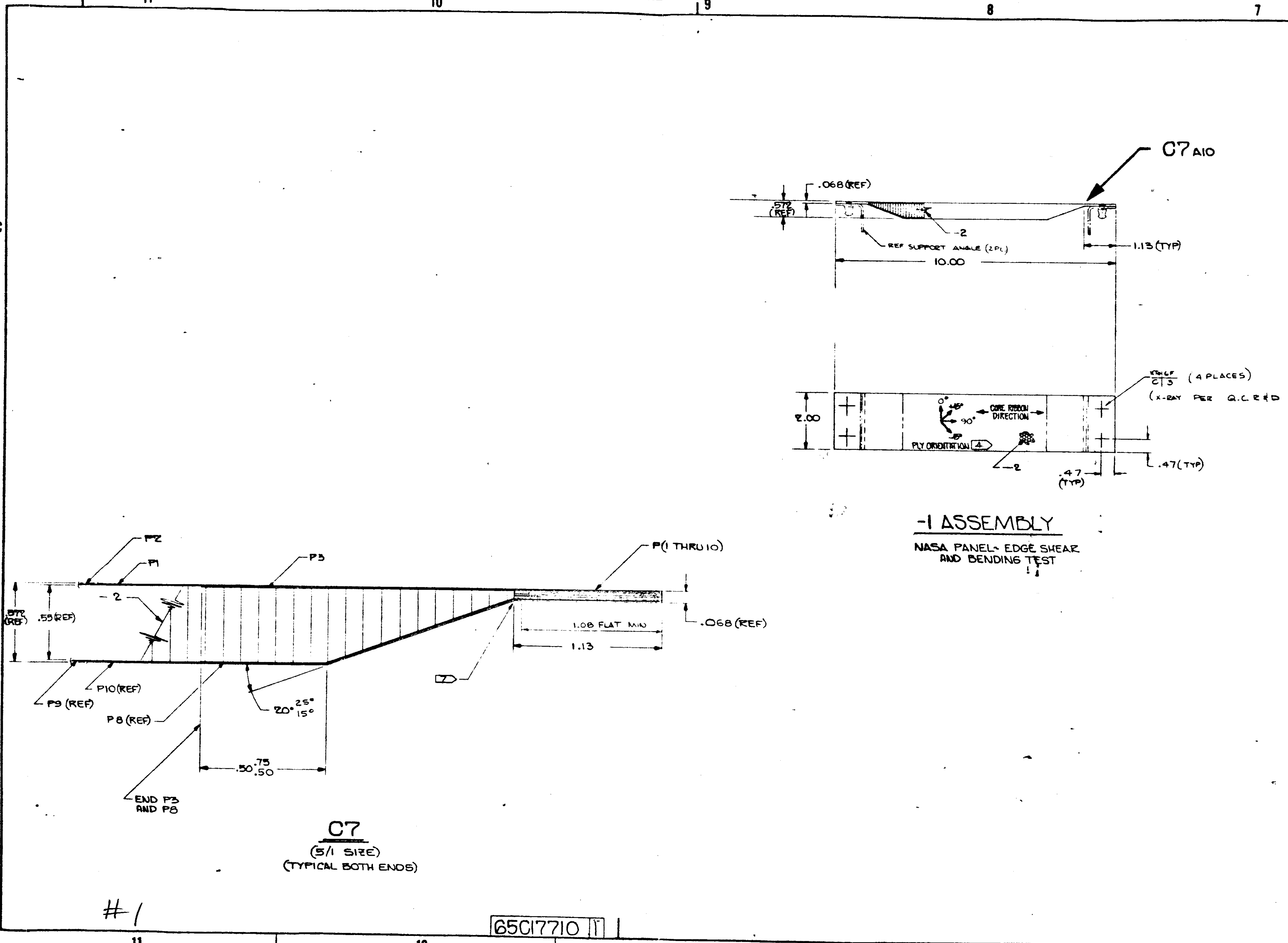
DRAWN Ken Houng 8/4/77
CHECKED
STRESS
ENGR.
GROUP
PROJ

THE BOEING COMPANY
COMMERCIAL AIRPLANE DIVISION RENTON, WASH

NASA HONEYCOMB PANEL SPECIMEN-STABILITY TEST, 727 ELEVATOR ADVANCED COMPOSITES (TEST #10)

CODE IDENT NO 81205 SIZE J 65C17709
SCALE 1/2 AND NOTED SH 1

A-11



C7 A10
.068 (REF)
.572 (REF)
-2
REF SUPPORT ANGLE (2 PL)
1.13 (TYP)
10.00
(4 PLACES)
(X-RAY PER Q.C. REQD)
2.00
0°
45°
90°
CORE RIBBON DIRECTION
PLY ORIENTATION 4
.47 (TYP)
-1 ASSEMBLY
NASA PANEL- EDGE SHEAR AND BENDING TEST
P2
P1
P3
P(1 THRU 10)
.572 (REF)
.55 (REF)
1.08 FLAT MIN
1.13
P10 (REF)
P9 (REF)
P8 (REF)
20° 25° 15°
.50 .75 .50
END P3 AND P8
C7
(5/1 SIZE)
(TYPICAL BOTH ENDS)
#1
65C17710 1

"PLY TABLE"

PART NUMBER	PLY NUMBER "P"	CLOTH WARP OR TAPE ORIENTATION	MATERIAL	SPLICE	REV LTR
-1	2 AND 10	+45°	1	NONE	
	1	90°	2	5	
	3,5,6,&8	0°	1	NONE	
	4 AND 7	-45°	1	NONE	
	9	90°	2	6	

REQUIREMENTS).

1. EPOXY PREIMPREGNATED GRAPHITE FABRIC PER XBMS 8-212, TYPE II, CLASS 2, STYLE 3K-70-P. FABRICATE PER XBAC 5562. SEE "PLY TABLE" (ZONE D6) FOR USAGE.

2. EPOXY PREIMPREGNATED GRAPHITE UNIDIRECTIONAL TAPE PER XBAC 8-212, TYPE II, CLASS 1, GRADE 95. FABRICATE PER XBAC 5562. SEE "PLY TABLE" (ZONE D6) FOR USAGE.

3. BMS 8-124, CLASS IV, TYPE V, GRADE 3 HONEYCOMB CORE (1/8 INCH CELL NOMEX).

4. PLY ORIENTATION CONVENTION:
   FABRIC: 0° IS PARALLEL TO THE WARP DIRECTION.
   TAPE: 0° IS PARALLEL TO THE FIBER DIRECTION.

5. BUTT SPLICE PER XBAC 5562 EXCEPT OVERLAP $.10^{\pm.10}$ NS.

6. BUTT SPLICE PER XBAC 5562, .00 TO .06 GAP

7. FILLER PLIES TO BE BUTTED TO CORE EDGE WITH AN OVERLAP OF .00 TO +.20 TO PROVIDE A SMOOTH TRANSITION FROM FLAT AREA TO CORE RAMP.

8. APPLY ONE LAYER OF TEDLAR FILM (PVF) TRANSPARENT 00 BG 30 TR PER BAC 5470 SECTION 7.5K ON THE OUTER SURFACE OF INNER FACE PLY (P10).

FINISHED GRAPHITE EPOXY SPECIMENS SHOULD HAVE SMOOTH SHARP CUT EDGES, SQUARE CORNERS AND SQUARE EDGES, WITH NO TAPERED OR FEATHERED EDGES.

INSTALL 6/6 DIA HI-LOKS IN $.1895^{.1925}_{.1895}$ DIA HOLES.

RELEASE	QTY REQD	PART OR IDENTIFYING NUMBER	NOMENCLATURE OR DESCRIPTION	ZONE	MATERIAL AND SPECIFICATION
✓	1	-2	H/C CORE	B5	3 .55 × 2.0 × 8
—	—	-1	NASA MODEL SPECIMEN ASSY EDGE SHEAR & BUCKLING TEST	2B	1 2
-1					

LIST OF MATERIAL

65C17710 | T

#2

2

DIMENSIONING & TOLERANCING PER USAS Y14.5
MARKING PER BAC 5307
MCD 2007 FOR SURFACE ROUGHNESS
DRILL, PUNCH, STRAIGHTEN & FIT METAL PARTS
BAC 5300
& NUT INSTALLATION
BAC 5009
FINAL SUBSTITUTION & EQUIVALENTS
BAC 5005
MATERIALS SUBSTITUTIONS
MANUFACTURING PROCESSES
D6-19736
FINISH CODES, SEE DOCUMENT
1000 &/OR D6-5000

FASTENER SYMBOL CODE

INSTL. STD. PER BAC 5004; FLUID TIGHT PER BAC 5047

BASIC CODE: ENCLOSED = FLUID TIGHT; OPEN = STANDARD
DIA DASH NO
MFD HEAD LOC: N = NEAR SIDE; F = FAR SIDE
XX | XX
DXC | XW
DIMPLE/CSK INFO: D = DIMPLE; X = NO SH DIMPLED; C = CSK IN STRUCTURE; 2 LINES TOP = MFD HD, BOTTOM = DRIVEN HD
SPOT WELD OPT
LENGTH DASH NO

NOTE: PROTRUDING HD RIVETS DRIVEN FLUSH
D/C INFO (2 LINES) APPLIES TO DRIVEN HD ONLY

HOLE LOCATION FOR 1/16 DIAMETER RIVET
HOLE LOCATION FOR 1/16 DIAMETER BOLT

XTO = BACB30NW( )( ) + BACC30M( )

SYM	ZONE	REVISIONS DESCRIPTION	DATE	APPROVAL

C

B

A

#3

	TEST ONLY						
NEXT ASSY	USED ON	SECT NO	SERIAL NUMBER	PART NUMBER	RELEASE COLUMN INDICATOR	DRAWING SHEET NUMBER	REV LTR
APPLICATION							

	M	
B	RS	
FINISH	PT MK	REV LTR

CHANGE NO: EWA 1211 FT

DWG ORIG BY (GROUP): ADVANCE COMPOSITES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES: ANGLES ± 2° DECIMALS ± .03
RIVET & BOLT EDGE MARGINS + .05
SHEET METAL CORNER RADII: INTERNAL 10 19/16; EXTERNAL 22 25/08
BEND RADII: 1 01 ON 03 & 06; 1 03 ON 09 & GREATER

DRAWN: Ken Young 9/18/77
CHECKED
STRESS
ENGR
GROUP
PROJ

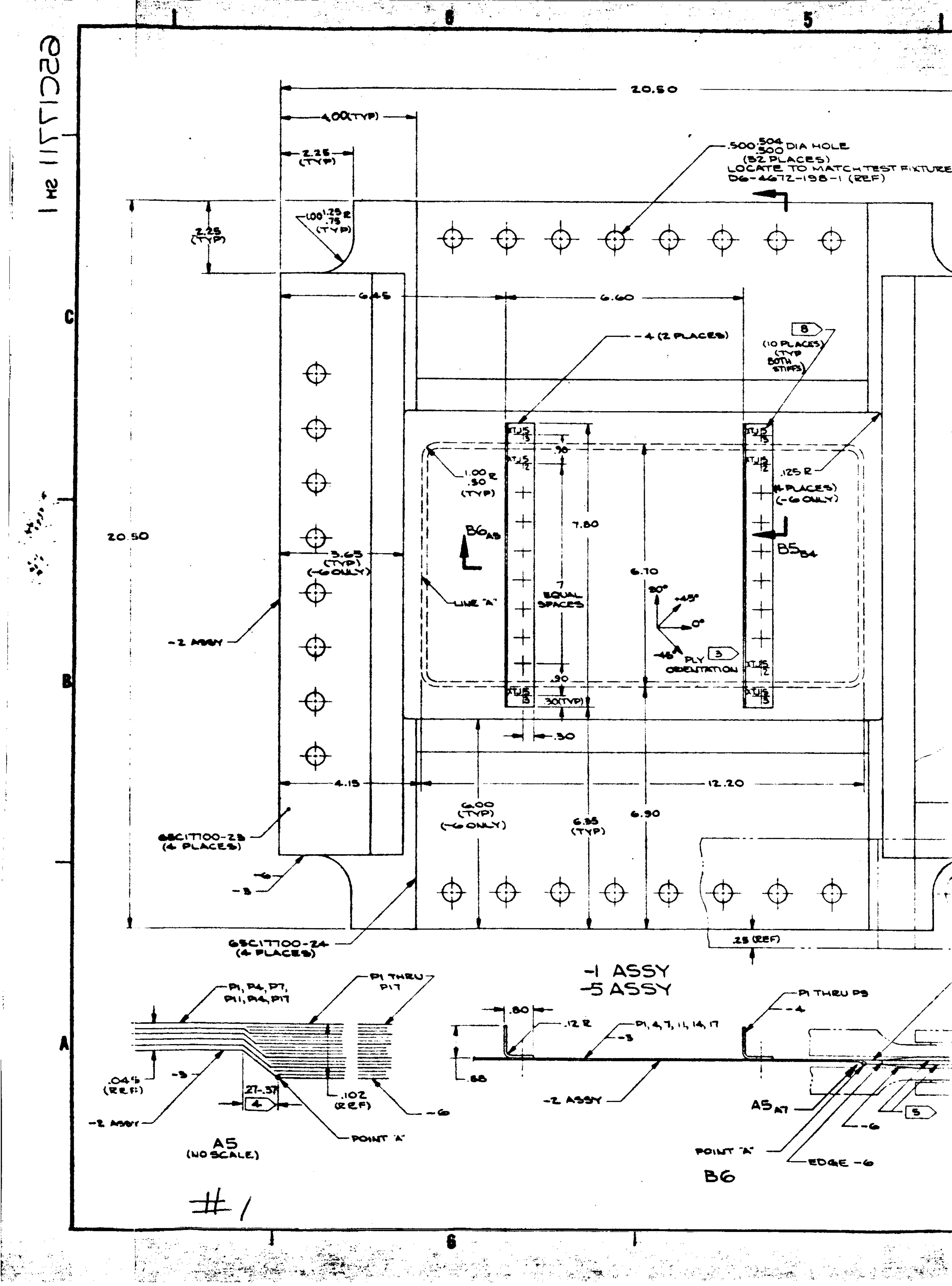
THE **BOEING** COMPANY
COMMERCIAL AIRPLANE DIVISION RENTON WASH

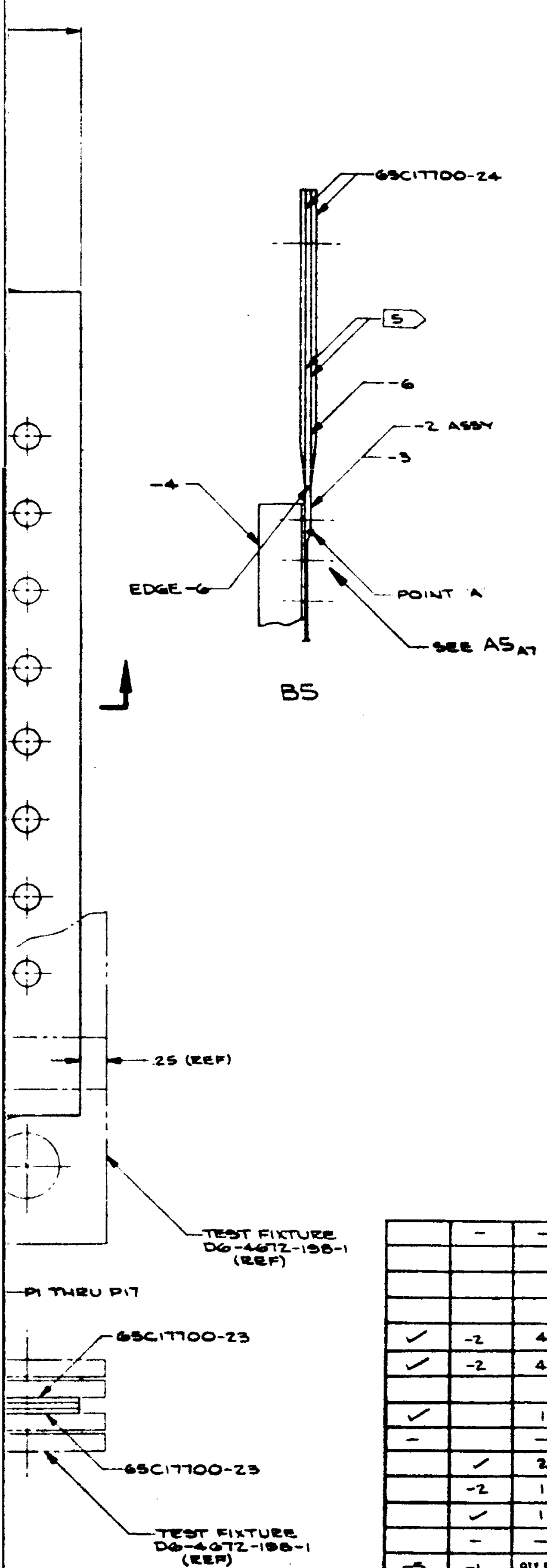
NASA PANEL SPECIMEN~
EDGE SHEAR AND BENDING TEST #2
727 ELEVATOR, ADVANCE COMPOSITES

CODE IDENT NO 81205 | SIZE J | 65C17710
SCALE 1/1 UNLESS NOTED

65C17710 | 1

1


20.50
4.00 (TYP)
2.25 (TYP)
.500 .504/.500 DIA HOLE
(32 PLACES)
LOCATE TO MATCH TEST FIXTURE
D6-4672-198-1 (REF)
1.00 1.25/.75 R (TYP)
6.45
6.60
-4 (2 PLACES)
8
(10 PLACES) (TYP BOTH STIFFS)
1.00/.50 R (TYP)
.125 R
(4 PLACES) (-6 ONLY)
7.80
B6 A5
B5 B4
3.65 (TYP) (-6 ONLY)
LINE "A"
7 EQUAL SPACES
6.70
90°
+45°
0°
-45°
PLY ORIENTATION 3
-2 ASSY
.90
.30 (TYP)
.30
4.15
12.20
6.00 (TYP) (-6 ONLY)
6.35 (TYP)
6.90
65C17700-23 (4 PLACES)
-6
-3
65C17700-24 (4 PLACES)
.25 (REF)
-1 ASSY
-5 ASSY
P1, P4, P7, P11, P14, P17
P1 THRU P17
.045 (REF)
27-.37
4
.102 (REF)
POINT "A"
A5 (NO SCALE)
.80
.12 R
P1, 4, 7, 11, 14, 17
P1 THRU P9
.88
A5 A7
5
EDGE -6
B6
#1
6
5
C
B
A
65C17700 SH 1



1. EPOXY PREIMPREGNATED GRAPHITE WOVEN FABRIC PER XBMS 8-212, TYPE II, CLASS 2, STYLE 3K-70-P. FABRICATE PER XBAC 5562.
2. EPOXY PREIMPREGNATED GRAPHITE UNIDIRECTIONAL TAPE, TYPE II, CLASS 1, GRADE 95 PER XBMS 8-212. FABRICATE PER XBAC 5562.
3. PLY ORIENTATION CONVENTION:
   FABRIC: 0° IS PARALLEL TO THE WARP DIRECTION
   TAPE: 0° IS PARALLEL TO THE FIBER DIRECTION
4. DROP OFF PLIES AT EQUAL SPACING WITHIN THE CUTOFF AREA.
5. BOND GRIP DOUBLER TO GRAPHITE/EPOXY WEB WITH BMS 5-80, TYPE 2, GRADE 5, CLASS II (BMS 5-51 OPTIONAL) PER BAC 5514-580 (PEEL PLY REQUIRED ON BONDING SURFACE)
6. INSTALL ALL BACC30M* COLLARS WITH BACW10BX*L WASHER UNDER COLLAR
7. BUTT SPLICE PER XBAC 5562, .00-.06 GAP
8. X-RAY INSPECT HOLE PER QC R&D REQUIREMENTS

DIMENSIONING & TOLERANCING PER USAS Y14.5
PART MARKING PER BAC 5307
SEE BACB 3097 FOR SURFACE ROUGHNESS
FORM, PUNCH, STRAIGHTEN & FIT METAL PARTS PER BAC 5300
BOLT & NUT INSTALLATION PER BAC 5009
MATERIAL SUBSTITUTION & EQUIVALENTS PER BAC 5005
SST MATERIALS SUBSTITUTIONS & MANUFACTURING PROCESSES PER D6-19726
FOR FINISH CODES, SEE DOCUMENT D2-5000 & OR D6-5000

FASTENER SYMBOL CODE	
INSTL: STD. PER BAC 5004, FLUID TIGHT, PER BAC 5047	
BASIC CODE — ENCLOSED= FLUID TIGHT, OPEN = STANDARD	DIA DASH NO; MFD HEAD LOC; N= NEAR SIDE; F= FAR SIDE
DIMPLE/CSK INFO — D= DIMPLE; 2 IND. SH DIMPLED; C= CSK INSTRUCTURE; 2 LINES: TOP= MFD HD, BOTTOM= DRIVEN HD	XX / DC XW — SPOT WELD OPT; LENGTH DASH NO.
NOTE: PROTRUDING HD RIVETS DRIVEN FLUSH. B/C INFO (2 LINES) APPLIES TO DRIVEN HD ONLY	
HOLE LOCATION FOR 1/8 DIAMETER RIVET	
HOLE LOCATION FOR 1/8 DIAMETER BOLT	
XTJ = BACB30MY*	C* = BACC30M* 6

INSTALL 5/32 DIA FASTENERS IN .1635 $^{.1665}_{.1635}$ DIA HOLE

FINISHED GRAPHITE/EPOXY SPECIMENS SHOULD HAVE SMOOTH SHARP CUT EDGES, SQUARE CORNERS & SQUARE EDGES WITH NO TAPERED OR FEATHERED EDGES.

PLY TABLE

PART NO.	PLY NO. "P"	MATL & SPEC	ORIENTATION	SPLICE
-3 ↕ -6	1, 7, 11, 17	1	+45°	—
	4, 14		-45°	
	2, 3, 5, 6, 8, 9 10, 12, 13, 15, 16	2	0°	7
-4	1, 5, 9	1	+45°	—
	3, 7		-45°	
	2, 8		0°	
	4, 6		90°	

-5	-1	QTY REQD	PART OR IDENTIFYING NUMBER	NOMENCLATURE OR DESCRIPTION	ZONE	MATERIAL AND SPECIFICATION	WT-PR	FINISH	PT-MK	REV LTR
	—	—	XBAC 5562	PROCESS SPEC						
✓	-2	4	65C17700-24	GRIP DOUBLER						
✓	-2	4	65C17700-23	GRIP DOUBLER						
✓		1	-6	WEB	A6	1 2			M	
—		—	-5	NASA TEST SPECIMEN	A6				M	
	✓	2	-4	STIFFENER	C6	1			M	
	-2	1	-3	WEB	A6	1 2			M	
	✓	1	-2	WEB ASSY	B6				M	
	—	—	-1	NASA TEST SPECIMEN	A6				M	

RELEASE — LIST OF MATERIAL

65C17711 | 1

#2

NEXT ASSY	USED ON	SECT NO	SERIAL NUMBER	PART NUMBER	RELEASE COLUMN INDICATOR	DRAWING SHEET NUMBER	REV LTR

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES: ANGLES ± 2° DECIMALS ±.03
RIVET & BOLT EDGE MARGINS ±.03
SHEET METAL CORNER RADII INTERNAL $\frac{1}{16}$ EXTERNAL $\frac{1}{32}$
BEND RADII: .1 ON .03 & .06; .03 ON .09 & GREATER

CHANGE NO. EWA 1211GT
PREPARED BY (GROUP) ADVANCED COMPOSITES

DRAWN SORENSEN
CHECKED
STRESS
ENGR
GROUP
PROJ

THE BOEING COMPANY
COMMERCIAL AIRPLANE DIVISION RENTON, WASH.

NASA TEST SPECIMEN- SPAR SHEAR WEB/ STIFFENER (TEST #9)

CODE IDENT NO. 81205 | SIZE J | 65C17711
SCALE | SH OF

65C17711 | 1

DRAWING RECORDS CLERK

A-13